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REPORT NO. : P WMA 12/T30/00/5314/15

Environmental Impact Assessment

for the proposed

MZIMVUBU WATER PROJECT

DEA Ref. No.: 14/12/16/3/3/2/677 (Dam construction)
14/12/16/3/3/2/678 (Electricity generation)
14/12/16/3/3/1/1169 (Roads)

AQUATIC ECOLOGY ASSESSMENT

SEPTEMBER 2014

Prepared for:

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ENVIRONMENTAL IMPACT ASSESSMENT FOR THE MZIMVUBU WATER PROJECT

Report Title:	***Aquatic Ecology Assessment***
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ENVIRONMENTAL IMPACT ASSESSMENT FOR THE MZIMVUBU WATER PROJECT

LIST OF REPORTS

REPORT TITLE	**DWS REPORT NUMBER**
Inception Report	P WMA 12/T30/00/5314/1
Scoping Report	P WMA 12/T30/00/5314/2
Environmental Impact Assessment Report	P WMA 12/T30/00/5314/3
Environmental Management Programme	P WMA 12/T30/00/5314/14
Water Use Licence Application Supporting Documents	P WMA 12/T30/00/5314/4
Ntabelanga Dam borrow pits and quarry Environmental Management Plan	P WMA 12/T30/00/5314/5
Lalini Dam borrow pits and quarry Environmental Management Plan	P WMA 12/T30/00/5314/6
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Visual Impact Assessment	P WMA 12/T30/00/5314/9
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Faunal Impact Assessment	P WMA 12/T30/00/5314/11
Heritage Impact Assessment	P WMA 12/T30/00/5314/12
Water Quality Study	P WMA 12/T30/00/5314/13
Aquatic Ecology Assessment	**P WMA 12/T30/00/5314/15**
Wetland Assessment	P WMA 12/T30/00/5314/16

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE MZIMVUBU WATER PROJECT

DEA REF No. 14/12/16/3/3/2/677 (Dam construction application)
14/12/16/3/3/2/678 (Electricity generation application)
14/12/16/3/3/1/1169 (Roads application)

This report is to be referred to in bibliographies as:

Department of Water and Sanitation, South Africa (2014). ***Environmental Impact Assessment for the Mzimvubu Water Project: Environmental Impact Assessment Report – Aquatic Ecology Assessment***

DWS Report No: **P WMA 12/T30/00/5314/15**

Prepared for: Directorate – Options Analysis

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DECLARATION OF INDEPENDENCE

I, Stephen van Staden as authorised representative of Scientific Aquatic Services, hereby confirm my independence as a specialist and declare that neither I nor Scientific Aquatic Services have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which Scientific Aquatic Services was appointed as environmental impact assessment specialists in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for worked performed, specifically in connection with the Aquatic Ecological Impact Assessment for the Mzimvubu Water Project Environmental Impact Assessment. I further declare that I am confident in the results of the studies undertaken and conclusions drawn as a result of it – as is described in my attached report.

Signed: Staden Date: 26/08/2014

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE MZIMVUBU WATER PROJECT

AQUATIC ECOLOGY ASSESSMENT

Executive summary

BACKGROUND AND OBJECTIVES

Scientific Aquatic Services (SAS) was appointed to undertake a Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) analysis of the wetland, aquatic and riparian resources and assess the impact of the proposed project on aquatic ecology, and propose mitigation, if required, as part of the environmental assessment and authorisation process for the proposed Mzimvubu water project in the Eastern Cape. The project consists of the construction of two large reservoirs and associated infrastructure. The Ntabelanga dam is to be used for water supply. The Lalini Dam is to be used to provide hydro-electric power to feed back into the South African electrical supply grid, as well as to provide energy to pump water from the Ntabelanga Dam to the areas earmarked for irrigation.

ASSESSMENT OF AQUATIC ECOLOGY

Specific outcomes required from this report in terms of the aquatic assessment include the following:

- Define the ecostatus of the river systems;
- Define the ecological importance and sensitivity of the systems based on stressor and receptor assessments, including habitat assessments;
- Biota specific water quality assessment;
- Aquatic and riparian zone habitat assessments;
- Aquatic community integrity assessments;
- Define impacts on the systems;
- Provide an opinion based on the study from an aquatic ecological point of view; and
- Present required mitigation measures.

Based on the assessment the EIS, PES and DEMC of the systems in the area can be summarised as follows:

Development	Relevant sites	EIS	PES	DEMC
Ntabelanga Dam development	TS1 and TS4	High	C	B
Roads associated with Ntabelanga Dam construction	TS2, TS3 and TS5	Moderate to high	C	C/B
Area between Ntabelanga Dam and Lalini Dam	TS6	Moderate to high	C	C/B
Lalini Dam development	TS7 and TS8	Moderate	C	C
Pipeline development	TS9	Moderate to high	C	C/B
EIS = Ecological importance and sensitivity; PES = Present ecological state; DEMC = Desired ecological management class.				

A Summary of the results (ecological categories) obtained from the application of the various indices to the Tsitsa River and tributaries as assessed during April 2014 and June 2014 is presented in the table below:

Assessment	Month	Sites								
		Tsitsa River				Inxu River (TS6) and other unnamed tributaries of the Tsitsa River				
		TS1	TS4	TS7	TS8	TS2	TS3	TS5	TS6	TS9
IHIA	April 2014*	B	B	C	C	C	B	C	C	C
IHAS	April 2014	Highly suited	Ade-quite.	Ade-quite.	Ade-quite.	Ade-quite.	Inade-quate.	Inade-quate.	Ade-quate.	Ade-quate.
	June 2014	Ade-quite.	Ade-quite.	Ade-quite.	Highly suited	Ade-quite.	Inade-quate.	Inade-quate.	Ade-quate.	Ade-quate.
Dickens and Graham (SASS5)	April 2014	C	C	C	C	D	C	D	C	D
	June 2014	C	C	D/E	C	D	C	E	D	E
Dallas (SASS5)	April 2014	A	C	A	A	D/E/F	E/F	D	E/F	D/E/F
	June 2014	B	C	D	B	B	D/E/F	E/F	D/E/F	E/F
MIRAI	April 2014	B	C	B	C	D	C	D	C	D
	June 2014	C	C	C	C	C	C	D	C	D
FRAI	April 2014*	D	D	D	D	**	**	**	E	E

Abbreviations and footnotes:
IHIA = Invertebrate habitat integrity assessment;
IHAS = Invertebrate habitat assessment;
SASS5 = South African scoring system;
MIRAI = Macro-invertebrate response assessment index;
FRAI = Fish response assessment index.
NA = Not assessed;
*April 2014 conditions also representative of June 2014 conditions with reference to IHIA and FRAI;
** Conditions not suitable for habitation by fishes.

Conclusions

The following general conclusions were drawn upon completion of the aquatic impact assessment evaluation:

The ecological importance of the greater study area is reflected in the aquatic assessment results obtained, particularly with reference to the four sites on the larger Tsitsa River (Ecostatus values ranging between A (Natural) to C (moderately modified) for assessments pertaining to invertebrates and invertebrate habitat). Fish fauna diversity was, however, depauperate as was also indicated in literature sources consulted.

Smaller streams are thought to be less resilient to environmental change and more sensitive to disturbances, simply because of the smaller spatial scale in terms of potential areas of refugia and associated faunal and floral diversity to act as "buffer" to change. This is also reflected in the assessment results, with the tributary assessments generally yielding lower classifications.

Seasonal changes in terms of the macro-invertebrate assessments are evident, with lower classifications being recorded during the lower flow period in June 2014. However, the contributions of lower flow and hence also potentially poorer water quality, as well as potential diffuse and point sources (agriculture activities and existing rural settlements) cannot be quantified at present.

A summary of site relevance to proposed projects and general potential impacts associated with such development is provided below:

Development	Relevant sites	General potential impacts
Ntabelanga Dam and associated infrastructure development	TS1 and TS4	Both sites are located on the Tsitsa River. During the construction phase destruction of bank cover and release of silt/sediment particles possibly resulting in discoloration and inundation is considered to be the most important potential impacts. After construction disruption of flow, also in terms of seasonal flow patterns, is considered the most significant impact along with the extensive loss of natural riverine habitat due to the inundation of the valley and the associated loss of aquatic community structure sensitivity and function. This impact is particularly pertinent as the system is reliant on clear fast flowing water to support the aquatic macro-invertebrate community of the area (as deduced from the MIRAI habitat preference tables discussed previously). Impacts on the Tsitsa River may thus impact the system on a much larger scale. Given the depauperate fish species diversity, potential impact on macro-invertebrates communities are expected to be far more significant throughout the system than on the fish community. However the still deep impoundments created are likely to lead to a very significant increase in the population of the alien fish species *Cyprinus carpio* and *Micropterus Salmoides* and increased impacts on the migratory connectivity of eels. The area is known to harbour endemic mayflies (Kleynhans 1999). With the location of the two dams situated between two waterfalls and hence geographically isolated, the area is likely to contain several macro-invertebrate species of conservation concern. Both prior to and after mitigation this impact is considered to be high to moderately high. Through minimising the time in which stream flow, water quality and habitat is affected during the construction phase of the project, this impact can, however, be mitigated to a limited degree.
Roads associated with Ntabelanga Dam construction	TS2, TS3 and TS5	Anticipated impacts resulting from construction and use of roads include vegetation removal, increased risk of erosion, sediment loading into the system and inhibition of water flow. If not designed correctly, roads can severely impact on in-stream habitat as well as bankside stability and riparian habitat
Area between Ntabelanga Dam and Lalini Dam	TS6	The Inxu River is the largest tributary and may also potentially act as "refugia" from where smaller tributaries can be populated. However, with limited diversity of flow and habitat types (very little rocky habitat) the potential to do so is also limited.
Lalini Dam development	TS7 and TS8	As for sites TS1 and TS4 and the Ntabelanga dam site.
Pipeline development	TS9	Impact resulting from construction of pipelines and use of roads as well as extensive digging are considered the greatest risk. Impacts as for TS2, TS3 and TS5.

Impact assessment:

Impact assessment results are summarised in the table below:

Impact	Construction and first filling		Operational phase	
Mitigation status	Unmitigated	Mitigated	Unmitigated	Mitigated
Roads and Infrastructure	Very low	Very low	Very low	Very low
Electricity Generation and Distribution impact on habitat	Medium low	Low	Medium low	Very low
Electricity Generation and Distribution impact on flow dependant species	Medium low	Low	Medium low	Very low
Electricity Generation and Distribution impact on species diversity	Medium low	Low	Low	Medium low
Electricity Generation and Distribution impact on SCC	Low	Very low	Low	Very Low
Dam impact on habitat	High	High	High	Medium high
Dam impact on flow dependant species	High	High	High	Medium high
Dam impact on species diversity	High	High	Medium high	Medium high
Dam impact on SCC	High	Medium high	Medium high	Medium low

Dam construction and operation

In terms of both dam and associated infrastructure construction and first filling phase, greatest impact pertains to habitat alteration/destruction as well as natural flow rate. These impacts result in secondary impacts on flow sensitive species, species of conservation concern and aquatic biodiversity in general. The effects (inundation of habitat upstream of the dam walls and disruption of natural flow downstream) are considered high impact and permanent and hence also applicable to the operation phase. In terms of dam size alternatives, the impact on the aquatic system will be largely the same with only slight impact in terms of scale, moving more towards a local impact compared to a site impact. In terms of flow rate, base flows need to be maintained during both the construction/initial filling and operation phases. Without periodic, seasonal floods with associated "purging" of the river system, impacts such as silting/sedimentation and decrease in general water quality is a possibility.

Key mitigation measures to limit the impact include:

- The construction of the dams will lead to reduced stream flow and hence loss of fast shallow riffle habitat and glide habitat. This impact is considered to be of high significance in the construction phase and even with mitigation the impact remains relatively unchanged. It is however deemed important that during construction the maintenance of base flows in the system is maintained at all times and that the duration of impacts on flows is limited to as short a period as possible;
- Ensure that all stockpiles are well managed and have measures such as berms and hessian sheets implemented to prevent erosion and sedimentation;

- Through ensuring that good construction practice is followed in terms of the clearing of areas, such as the use of water control berms and clearing footprint areas that are as small as possible, the severity of the impact can be reduced;
- Ongoing aquatic biomonitoring on a minimum of a quarterly basis must take place from six (6) months prior to construction till one (1) year after construction to determine trends in ecology and define any impacts requiring mitigation;
- It must be ensured that downstream of both the Ntabelanga dam as well as Lalini Dam that the flows as defined in the EWR are maintained at all times to support the flow sensitive aquatic macro-invertebrate community in this system;
- Impact on flow-dependent species is considered to be of high to very high importance in the construction phase and even with mitigation the impact remains relatively unchanged;
- During construction, the maintenance of base flows in the system must be maintained at all times and the duration of impacts on flows should be limited to as short a period as possible;
- During construction the maintenance of base flows in the system must be maintained at all times and the duration of impacts on flows should be limited to as short a period as possible;
- Eelways should be included in the design of the dam walls
- Loss of habitat will impact on a regional scale with the duration permanent however impacts downstream of the impoundments can be mitigated through management of the flow regime. The intensity of impact is considered high, with loss of resources and a definite probability of occurrence in all instances. Maintenance of base flow is to be maintained with seasonal peak flow management (winter) limiting daily variations in habitat availability to a single season;
- The impact on the aquatic community structures within the full supply level will be very significant with drastic changes to the aquatic community structure in these areas with more sensitive taxa no longer occurring and less desirable species of fish becoming dominant in the system;

Electricity generation and distribution

Construction of such infrastructure will be of low impact if mitigated. Mitigation includes minimising the spatial footprint of the development to the greatest degree possible, with special reference to avoiding erosion, silting and sedimentation within the aquatic system. During the operation phase discharge through the Lalini Dam tunnel into the river will also be applicable. The section of river below the dam wall up to the tunnel discharge point will be largely subjected to base flow as defined by the EWR, which may impact on the most flow sensitive biota.

Peak electricity generation is not deemed appropriate to the system as it will significantly impact on the ecology of the system. Base energy generation would impact on the system unless variable base generation can be employed. Non variable base generation is therefore not deemed appropriate for this project. Base generation which is regulated in line with releases to meet EWR's and mimic natural discharge patterns through the year is deemed the most appropriate regime for the project;

As mentioned previously this may result in silting, sedimentation, decrease in water quality and excessive vegetation growth. The shorter the length of this section between the dam wall and discharge point, the smaller the area of impact. The tunnel must also be positioned and designed in such a manner as to preclude erosion effects at times of peak discharge.

Road and pipeline infrastructure

Construction of such infrastructure will be of low impact if mitigated. Mitigation again includes minimising the spatial footprint of the development to the greatest degree possible, with special reference to avoiding erosion, silting and sedimentation within the aquatic system during both construction and operation. Good housekeeping and management principles must be instilled throughout the life of the project. During the operation phase increased run-off from hard surfaces may also result in erosion.

Throughout the life of the project ongoing aquatic biomonitoring must take place, and if any trends are observed where impacts on the aquatic ecology is becoming unacceptable, measures to reduce the impacts must be immediately implemented. All aquatic biomonitoring should be undertaken by a suitably qualified and South African River Health Program (SA RHP) accredited assessor.

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE MZIMVUBU WATER PROJECT – AQUATIC ECOLOGY IMPACT ASSESSMENT

DEA REF No. 14/12/16/3/3/2/677 (Dam construction application)
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ACRONYMS AND ABBREVIATIONS

AsgiSA-EC	Accelerated and Shared Growth Initiative for South Africa – Eastern Cape
BGIS	Biodiversity Geographic Information System
BID	Background Information Document
BLMC	Biodiversity Land Management Class
BMWP	Biological Monitoring Working Party
CBA	Critical Biodiversity Areas
CFRD	Concrete-faced rockfill dam
DEMC	Desired Ecological Management Class
DM	District Municipality
DWA	replace with DWS
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
EC	Eastern Cape
ECBCP	Eastern Cape Biodiversity Conservation Plan
ECRD	Earth core rockfill dam
EF	Earthfill (dam)
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMC	Ecological Management Class
EMPr	Environmental Management Programme
ESA	Ecological Supporting Areas
ESIA	Environmental and Social Impact Assessment
EWR	Environmental Water Requirements
FHA	Fish Habitat Assessment
FRAI	Fish Response Assessment Index
FSL	Full Supply Level
GERCC	Grout enriched RCC
GIS	Geographic Information System
GN	General Notice
GPS	Global Positioning System
HCR	Habitat Cover Ratings
HG	Hydrogeomorphic
HGM	Hydrogeomorphic Units
IHAS	Invertebrate Habitat assessment System
IHIA	Intermediate Habitat Integrity Assessment
IH	Index of Habitat Integrity
ISO	International Standards Organisation
IVRCC	Internally vibrated RCC
LM	Local Municipality
MAP	Mean Annual Precipitation
MAPE	Mean Annual Potential for Evaporation
MASMS	Mean Annual Soil Moisture Stress
MAT	Mean Annual Temperature

MIRAI	Macro-invertebrate Response Assessment Index
MPRDA	Mineral and Petroleum Resources Development
MW	Megawatt
NAEHMP	National Aquatic Ecosystem Health Monitoring Programme
NBA	National Biodiversity Assessment
NEMA	National Environmental Management Act
NEMBA	National Environmental Management Biodiversity Act
NFEPA	National Freshwater Ecosystem Priority Areas
NOCL	Non-overspill crest level
NOMR	New Order Mining Rights
NPAES	National Protected Area Expansion Strategy
NSBA	National Spatial Biodiversity Assessment
NWA	National Water Act
NWCS	National Wetland Classification System
PEMC	Present Ecological Management Class
PES	Present Ecological State
PPP	Public Participation Process
PRECIS	Pretoria Computer Information Systems
PSC	Project Steering Committee
PSP	Professional Services Provider
RAU	Rand Afrikaans University
RCC	Roller-compacted concrete
RDL	Red Data Listed
RDSIS	Red Data Sensitivity Index Score
REC	Recommended Ecological Category
RHP	River Health Program
SACNASP	South African Council for Natural Scientific Professions
SASSA	South African Soil Surveyors Association
SASS5	South African Scoring System 5
SASSO	South African Soil Surveyors Association
SANBI	South African National Biodiversity Institute
SAS	Scientific Aquatic Services
SMC	Study Management Committee
SPV	Special Purpose Vehicle
SQR NAME	Sub Quat River Name
TCTA	Trans Caledon Tunnel Authority
TSP	Threatened Species Programme
VEGRAI	Vegetation Response Assessment Index
WRYM	Water Resources Yield Model
WMA	Water Management Areas
subWMA	Sub-Water Management Area
WetVeg Groups	Wetland Vegetation Groups

LIST OF UNITS

GW	Gigawatt
GWh/a	Gigawatt hour per annum
MW	Mega Watt
m	Metre
km^2	Square Kilometres
kW	Kilowatt
ha	Hectare
°C	Degrees Celsius
%	Percentage
mS	Millisiemens
ℓ	Litre
ℓ/s	Litres per second
mL	Millilitre
million m^3	Million cubic metres

1. INTRODUCTION

1.1 BACKGROUND

The Department of Water and Sanitation (DWS) commissioned the Mzimvubu Water Project, an integrated multi-purpose (domestic water supply, agriculture, power generation, transport, tourism, conservation and industry) project, with the intention of providing a socio-economic development opportunity for the Eastern Cape region.

Environmental authorisation is required for the infrastructure components of the project. The purpose of the Environmental Impact Assessment (EIA) is to assess the components of the project that are listed activities by the National Environmental Management Act (NEMA) for which the Department of Water and Sanitation (DWS) has the mandate and intention to implement. The EIA process will provide the information that the environmental authorities require to decide whether the project should be authorised or not, and if so then under what conditions.

As part of this EIA process Scientific Aquatic Services have been contracted to undertake an Aquatic Ecological Impact Assessment.

1.2 PURPOSE OF THIS REPORT

Scientific Aquatic Services (SAS) was appointed to undertake a Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) analysis of the terrestrial wetland, aquatic and riparian resources and to assess the impact associated with the proposed development and to provide mitigatory measures as necessary as part of the environmental assessment and authorisation process for the proposed Mzimvubu water project in the Eastern Cape. Specific outcomes required from this report in terms of the aquatic assessment include the following:

- Define the ecostatus of the river systems;
- Define the ecological importance and sensitivity of the systems based on stressor and receptor assessments, including habitat assessments;
- Biota specific water quality assessment;
- Aquatic community integrity assessments;
- Define impacts on the systems;
- Provide an opinion based on the study from an aquatic ecological point of view; and
- Present required mitigation measures to minimise the impact on the receiving aquatic environment.

1.3 DETAILS AND EXPERTISE OF THE SPECIALIST

Stephen van Staden

SACNASP REG.NO: 400134/05

Stephen van Staden completed an undergraduate degree in Zoology, Geography and Environmental Management at RAU. On completion of this degree, he undertook an honours course in Aquatic health through the Zoology department at RAU. In 2002 he began a Masters degree in environmental management, where he did his mini dissertation in the field of aquatic resource management, also undertaken at RAU. At the same time, Stephen began building a career by first working at an environmental consultancy specialising in town planning developments, after which he moved to a larger firm in late 2002. From 2002 to the end of 2003, he managed the monitoring division and acted as a specialist consultant on water resource management issues and other environmental processes and applications. In late 2003, Stephen started consulting as an independent environmental scientist, specialising in water resource management under the banner of Scientific Aquatic Services. In addition to aquatic ecological assessments, clients started enquiring about terrestrial ecological assessments and biodiversity assessments. Stephen, in conjunction with other qualified ecologists, began facilitating these studies as well as highly specialised studies on specific endangered species, including grass owls, arachnids, invertebrates and various vegetation species. Scientific Aquatic Services soon became recognised as a company capable of producing high quality terrestrial ecological assessments. Stephen soon began diversifying into other fields, including the development of EIA process, EMPR activities and mine closure studies.

Stephen has experience on well over 1000 environmental assessment projects with specific mention of aquatic and wetland ecological studies, as well as terrestrial ecological assessments and project management of environmental studies. Stephen has a professional career spanning more than 10 years, of which almost the entire period has been as the owner and Managing member of Scientific Aquatic Services and the project manager on most projects undertaken by the company. Stephen has also obtained extensive experience in wetland and aquatic assessments in the Limpopo Plains aquatic ecoregion.

Stephen is registered by the SA RHP as an accredited aquatic biomonitoring specialist and is also registered as a Professional Natural Scientist with the South African Council for Natural Scientific Professions (SACNASP) in the field of ecology. Stephen is also a member of the Gauteng Wetland Forum and South African Soil Surveyors Association (SASSO).

Dionne Crafford
SACNASP REG.NO: 400146/14
Dionne Crafford matriculated in 1993 and obtained a BSc Ecology degree from the University of Pretoria in 1996. He obtained his BSc (Hons) Zoology degree with distinction at the same university in 1997, where he was awarded the Zoological Society of Southern Africa (ZSSA) award for the best honours student in Zoology. His honours project focused on behavioural ecology (grass owl acoustics).

He spent 1998 in the United States of America exploring various warm water fly fishing opportunities, before returning to enrol for an MSc in Zoology at the Rand Afrikaans University in 1999. He obtained the degree with distinction in 2000 and was awarded the Neitz Medallion for the best MSc in Zoology by the Parasitological Society of Southern Africa (PARSA). His MSc project was on aquatic environmental management/biological monitoring using catfish and their parasites as indicators of water quality.

From 2001 to 2006 he was first employed as "Veterinary Researcher" and later "Specialist Veterinary Researcher" by former Intervet at their Malelane research facility. From 2003 to 2006 he also performed part-time fly fishing guiding services for the former Fly Fishing Outfitters (Nelspruit). He moved to Bloemfontein in 2007 where he was employed as "Assistant Manager:

Endoparasitology" at ClinVet International (Pty) Ltd from 2007 to 2012. In 2009 he enrolled for a part-time PhD in Zoology (monogenean parasites of freshwater fish) at the University of Johannesburg and received his degree in 2013. As from 2013 he is employed as Associate Scientific Writing Manager at ClinVet and also performs scientific writing services for Scientific Aquatic Services. In the latter capacity he has participated in a number of studies relating to aquatic biomonitoring and toxicity testing.

1.4 STRUCTURE OF THIS REPORT

This specialist study is undertaken in compliance with Regulation 32 of GN 543. **Table 1** indicates how the requirements of Regulation 32 of GN 543 have been fulfilled in this report.

Table 1: Report content requirements in terms of Regulation 32 of GN 543

Regulatory Requirements in terms of Regulation 32 of GN 543	Section of Report
(a) The person who prepared the report; and the expertise of that person to carry out the specialist study or specialised process.	Chapter 1
(b) a declaration that the person is independent	Page iv
(c) an indication of the scope of, and the purpose for which, the report was prepared	Chapters 1 and 3
(d) a description of the methodology adopted in preparing the report or carrying out the specialised process	Chapter 3
(e) a description of any assumptions made and any uncertainties or gaps in knowledge	Chapter 4
(f) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Chapters 6 to 8
(g) recommendations in respect of any mitigation measures that should be considered by the applicant and the competent authority	Chapter 11
(h) a description of any consultation process that was undertaken during the course of carrying out the study	Chapter 9
(i) a summary and copies of any comments that were received during any consultation process	Chapter 9
(j) any other information requested by the competent authority.	Chapter 10

2. PROJECT BACKGROUND SUMMARY

2.1 LOCALITY

The project footprint spreads over three District Municipalities (DMs) namely the Joe Gqabi DM in the north west, the OR Tambo DM in the south west and the Alfred Nzo DM in the east and north east.

The proposed Ntabelanga Dam site is located approximately 25 km east of the town of Maclear and north of the R396 Road. The proposed Lalini Dam site is situated approximately 17 km north east of the small town Tsolo. Both are situated on the Tsitsa River.

2.2 MAIN PROJECT COMPONENTS

The project forms a large integrated project with several components. The proposed water resource infrastructure includes:

- A dam at the Ntabelanga site with a storage capacity of 490 million m^3;
- A dam at the Lalini site with a storage capacity of approximately 150 million m^3;
- A pipeline and tunnel and a power house at the Lalini Dam site for generating hydropower;
- Five new flow measuring weirs will be required in order to measure the flow that is entering and released from the dams. These flow gauging points will be important for monitoring the implementation of the Reserve and for operation of the dams.
- Wastewater treatment works at the dam sites;
- Accommodation for operations staff at the dam sites; and
- An information centre at each of the dam sites.

The Ntabelanga Dam will supply potable water to 539 000 people, which is estimated to rise to 730 000 people by the year 2050. The domestic water supply infrastructure will include:

- A river intake structure and associated works;
- A regional water treatment works at Ntabelanga Dam;
- Potable bulk water distribution infrastructure for domestic and industrial water requirements (primary and secondary distribution lines);
- Bulk treated water storage reservoirs strategically located; and
- Pumping stations.

The Ntabelanga Dam will also provide water to irrigate approximately 2 900 ha of arable land. This project includes bulk water conveyance infrastructure for raw water supply to edge of field.

About 2 450 ha of the high potential land suitable for irrigated agriculture are in the Tsolo area and the rest near the proposed Ntabelanga Dam and along the river, close to the villages of Machibini, Nxotwe, Culunca, Ntshongweni, Caba, Kwatsha and Luxeni.

There will be a small hydropower plant at the Ntabelanga Dam to generate between 0.75 MW and 5 MW (average 2.1 MW). This will comprise a raw water pipeline from the dam to a building containing the hydropower turbines and associated equipment, and a discharge pipeline back to the river just below the dam wall. The impact is expected to be similar to that of a pumping station.

The hydropower plant at the proposed Lalini Dam and tunnel (used conjunctively with the Ntabelanga Dam) will generate an average output of 35 MW when operated as a base load power station and up to 180 MW when operated as a peaking power station. The power plant will require a pipeline (approximately 4 km) and tunnel (approximately 4 km) linking the dam to the power plant downstream of the dam and below the gorge.

The power line to link the Lalini power station to the existing Eskom grid will be approximately 18.5 km and the power line linking the Ntabelanga Dam to the Eskom grid will be approximately 13 km.

The area to be inundated by the dams will submerge some roads. Approximately 80 km of local roads will therefore be re-aligned. Additional local roads will also be upgraded to support social and economic development in the area. The road design will be very similar to the existing roads as well as be constructed using similar materials.

The project is expected to cost R 12.45 billion and an annual income of R 5.9 billion is expected to be generated by or as a result of the project during construction and R 1.6 billion per annum during operation. It will create 3 880 new skilled employment opportunities and 2 930 un-skilled employment opportunities during construction.

2.3 ALTERNATIVES

The following project level alternatives will be assessed:

- Three hydro power tunnel positions and associated power lines;
- Peak versus Base load power generation;
- Three different dam sizes for the Lalini Dam; and
- The no project option.

For the construction camps, pipeline routes and new roads, the specialist will identify any sensitive areas and deviations to avoid these will be proposed in consultation with the technical team.

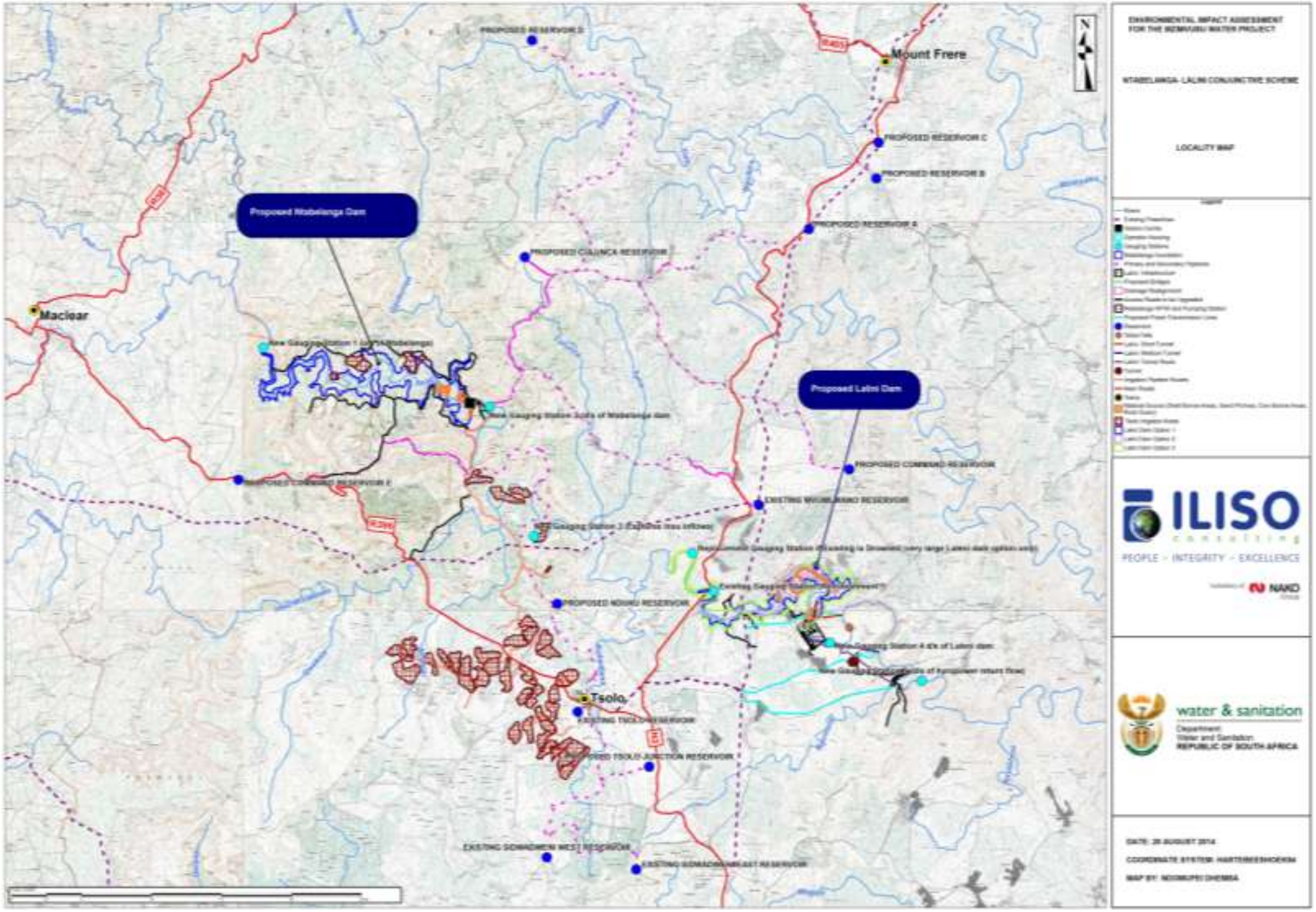


Figure 1: Locality map of the study area.

3. TERMS OF REFERENCE

3.1 SCOPE OF THE STUDY

3.1.1 Aquatic ecological assessment sites and site selection

Aquatic ecological assessments were undertaken at four points on the Tsitsa River. One point (TS1) was above the full supply level of the proposed Ntabelanga Dam with another point (TS4) located immediately upstream of the proposed wall position. Further downstream two points (TS7 and TS8 respectively) were located upstream of the full supply level and downstream of the wall of the proposed Lalini Dam development respectively. In addition five other assessment points were identified on tributaries of the Tsitsa River in the greater study area.

Table 2 presents geographic information with regards to the monitoring points on the Tsitsa River and associated tributaries assessed. **Figure 2** visually presents the locations of the various points along the various river systems, assessed either in the current assessment or by accessing information available from the literature review and historical data collected.

Table 2: Location of the biomonitoring points with co-ordinates

Site	Detailed Site Description	GPS coordinates	
		South	East
Riverine assessment points			
TS1	Site on the **Tsitsa River** upstream of the proposed Ntabelanga Dam and road upgrades development	31°06'19.63"	28°30'50.16"
TS4	Site on the **Tsitsa River** downstream of the proposed Ntabelanga Dam and road upgrade development	31°07'07.29"	28°40'11.38"
TS7	Site on the **Tsitsa River** upstream of the proposed Lalini Dam development	31°14'43.06"	28°50'30.74"
TS8	Site on the **Tsitsa River** downstream of the proposed Lalini Dam development	31°14'19.00"	28°56'14.15"
TS2	Site on an **unnamed tributary of the Tsitsa River** upstream of the proposed Ntabelanga Dam and road upgrade development	31°06'13.72"	28°30'53.72"
TS3	Site on an **unnamed tributary of the Tsitsa River** upstream of the proposed Ntabelanga Dam and road upgrade development	31°06'59.53"	28°30'50.13"
TS5	Site on an **unnamed tributary of the Tsitsa River** at the starting point of the proposed road upgrade development	31°13'12.12"	28°37'51.91"
TS6	Site on the **Inxu River** (tributary of the Tsitsa river) at the starting point of the proposed road upgrade development	31°12'37.94"	28°37'36.51"
TS9	Site on an **unnamed tributary of the Tsitsa River** directly associated with the proposed pipeline development	31°20'08.51"	28°45'54.20"

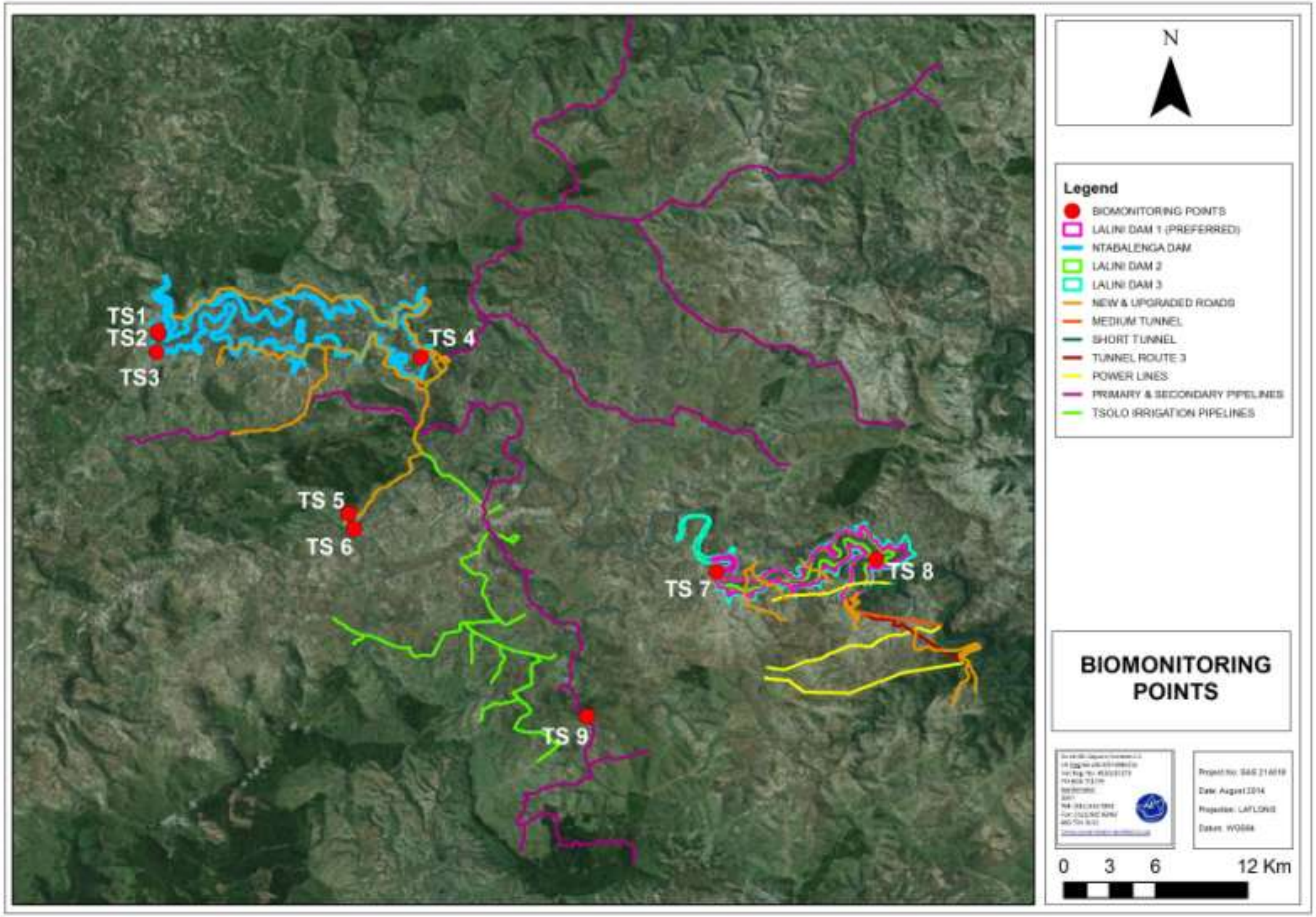


Figure 2: Digital satellite image of the study area showing assessment sites on the Tsitsa River (TS1, TS4, TS7 and TS8) as well as on tributaries of this river (TS2, TS3, TS5, TS6 and TS9) depicted on an aerial photograph in relation to surrounding areas.

The sites assessed were all visually assessed. In the field analyses of biota specific water quality variables took place at each point. In addition the Invertebrate Habitat Assessment System (IHAS), Intermediate Habitat Integrity Assessment (IHIA), the South African Scoring System version 5 (SASS5) and Macro-Invertebrate Risk Assessment Index (MIRAI) were applied along with an assessment of the fish community integrity to define the ecostatus of the aquatic resources in the vicinity of the proposed project area. The protocols of applying the indices were strictly adhered to and all work was carried out by a South African River Health Program (SA RHP) accredited assessor.

3.2 METHODOLOGY

3.2.1 Literature review

A desktop study was compiled with all relevant information as presented by the South African National Biodiversity Institutes (SANBI's) Biodiversity Geographic Information Systems (BGIS) website (http://bgis.sanbi.org). Wetland specific information resources taken into consideration during the desktop assessment of the study area included:

- National Freshwater Ecosystem Priority Areas (NFEPAs, 2011)
  - NFEPA water management area (WMA)
  - NFEPA wetlands/National wetlands map
  - Wetland and estuary FEPA
  - FEPA (sub)WMA % area
  - Sub water catchment area FEPAs
  - Water management area FEPAs
  - Fish sanctuaries
  - Wetland ecosystem types
- Threatened Terrestrial Ecosystems for South Africa, 2009
- National Wetlands Inventory, 2006

Studies undertaken by the Institute for Water Quality Studies assessed all quaternary catchments as part of the Resource Directed Measures for Protection of Water Resources. In these assessments, the EIS, Present Ecological Management Class (PEMC) and Desired Ecological Management Class (DEMC) were defined, and serve as a useful guideline in determining the importance and sensitivity of aquatic ecosystems.

Water resources are generally classified according to the degree of modification or level of impairment. The classes used by the South African River Health Program (RHP) are presented in **Table 3** and will be used as the basis of classification of the systems in the study area.

Table 3: Classification of river health assessment classes in line with the RHP

Class	Description
A	Unmodified, natural.
B	Largely natural, with few modifications.
C	Moderately modified.
D	Largely modified.
E	Extensively modified.
F	Critically modified.

In addition the ecological category (EC) classification will be employed using the eco-status A to F continuum approach (Kleynhans and Louw, 2007). This approach allows for boundary categories denoted as B/C, C/D etc., as illustrated in **Figure 3**.

Figure 3: Ecological categories (EC) eco-status A to F continuum approach employed (Kleynhans and Louw, 2007)

3.2.2 Visual assessment of aquatic assessment points

Each site was selected in order to identify current conditions, with specific reference to impacts from surrounding activities where applicable. Both natural constraints placed on ecosystem structure and function, as well as anthropogenic alterations to the systems identified, was identified by observing conditions and relating them to professional experience. Photographs of each site were taken to provide visual records of the conditions at the time of assessment. Factors which were noted in the site-specific visual assessments included the following:

- Upstream and downstream significance of each point, where applicable;
- Significance of the point in relation to the study area;
- stream morphology;
- instream and riparian habitat diversity;
- stream continuity;
- erosion potential;
- depth flow and substrate characteristics;
- signs of physical disturbance of the area;
- other life forms reliant on aquatic ecosystems.

3.2.3 Physico-chemical water quality data

On site testing of biota specific water quality variables took place on all sites where surface water was present. The results of on-site biota specific water quality analyses were used to aid in the interpretation of the data obtained from assessments of the aquatic community assemblages at each point. Results are discussed against the guideline water quality values for aquatic ecosystems (DWAF, 1996 vol. 7).

3.2.4 Intermediate habitat integrity assessment (IHIA)

It is important to assess the habitat of riverine systems in order to aid in the interpretation of the results of the community integrity assessments by taking habitat conditions and impacts into consideration. The general habitat integrity of the sites was assessed based on the application of the Intermediate Habitat Integrity Assessment for (Kemper 1999). The Intermediate Habitat Integrity Assessment (IHIA) protocol, as described by Kemper (1999), was used using the site specific application protocols. This is a simplified procedure, which is based on the Habitat Integrity approach developed by Kleynhans (1996). The IHIA is conducted as a first level exercise, where a comprehensive exercise is not practical. The Habitat Integrity of each site was scored according to 12 different criteria which represent the most important (and easily quantifiable) anthropogenically induced possible impacts on the system.

The in-stream and riparian zones were analysed separately, and the final assessment was then made separately for each, in accordance with Kleynhans' (1999) approach to Habitat Integrity Assessment. Data for the riparian zone is, primarily interpreted in terms of the potential impact on the in-stream component. The assessment of the severity of impact of modifications is based on six descriptive categories with ratings. Analysis of the data was carried out by weighting each of the criteria according to Kemper (1999). By calculating the mean of the instream and riparian Habitat Integrity scores, an overall Habitat Integrity score can be obtained for each site. This method describes the Present Ecological State (PES) of both the in-stream and riparian habitats of the sites. The method classifies Habitat Integrity into one of six classes, ranging from unmodified/natural (Class A), to critically modified (Class F).

3.2.5 Invertebrate habitat suitability [invertebrate habitat assessment (IHAS)]

The Invertebrate Habitat Assessment System (IHAS) was applied to all the sites according to the protocol of McMillan (1998). This index was used to determine specific habitat suitability for aquatic macro-invertebrates, as well as to aid in the interpretation of the results of the South African Scoring System version 5 (SASS5) scores. Scores for the IHAS index were interpreted according to the guidelines of McMillan (1998) as follows:

- <65%: habitat diversity and structure is inadequate for supporting a diverse aquatic macro-invertebrate community.
- 65%-75%: habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community.
- >75%: habitat diversity and structure is highly suited for supporting a diverse aquatic macro-invertebrate community.

3.2.6 Aquatic Macro-Invertebrates: South African Scoring System (SASS5)

Aquatic macro-invertebrate communities of all the sites were investigated according to the SASS5 method, which is specifically designed to comply with international accreditation protocols. This

method is based on the British Biological Monitoring Working Party (BMWP) method and has been adapted for South African conditions by Chutter (1998).
The assessment was undertaken according to the South African Scoring System (SASS) protocol as defined by Dickens and Graham (2001). All work was undertaken by an accredited South African Scoring System, version 5 (SASS5) practitioner.

Interpretation of the results of biological monitoring depends, to a certain extent, on interpretation of site-specific conditions (Thirion *et al.* 1995). In the context of this investigation it would be best not to use SASS5 scores in isolation, but rather in comparison with relevant habitat scores.

The reason for this is that some sites have a less desirable habitat or fewer biotopes than others do. In other words, a low SASS5 score is not necessarily regarded as poor in conjunction with a low habitat score. Also, a high SASS5 score in conjunction with a low habitat score can be regarded as better than a high SASS5 score in conjunction with a high habitat score.

A low SASS5 score together with a high habitat score would be indicative of poor conditions. The IHAS Index is valuable in helping to interpret SASS5 scores and the effects of habitat variation on aquatic macro-invertebrate community integrity.

The perceived reference state for the local streams was determined in consideration of the ecoregion conditions as well as local habitat conditions. Local conditions are generally adequate to highly suited for supporting a diverse aquatic macro-invertebrate community, particularly sites on the Tsitsa River, as is evident from IHAS scores. Fair diversities and abundances of aquatic macro-invertebrates can thus be expected.

Reference scores for sites on the larger Tsitsa River were defined as a SASS5 score of 170 and an Average Score Per Taxon (ASPT) of 7.5 (South Eastern Uplands Aquatic Ecoregion – Lower). Reference scores for sites on the smaller Tsitsa River tributaries were defined as a SASS5 score of 200 and an Average Score Per Taxon (ASPT) of 7.2 (South Eastern Uplands Aquatic Ecoregion – Upper).

Interpretation of the results in relation to the reference scores was made according to the classification of SASS5 scores presented in the SASS5 methodology published by Dickens and Graham (2001) (**Table 4**) as well as according to Dallas (2007) (**Figures 4 and 5**).

Table 4: Definition of Present State Classes in terms of SASS and ASPT scores as presented in Dickens and Graham (2001)

Class	Description	SASS Score%	ASPT%
A	Unimpaired. High diversity of taxa with numerous sensitive taxa.	90-100 80-89	Variable >90
B	Slightly impaired. High diversity of taxa, but with fewer sensitive taxa.	80-89 70-79 70-89	<75 >90 76-90
C	Moderately impaired. Moderate diversity of taxa.	60-79 50-59 50-79	<60 >75 60-75
D	Largely impaired. Mostly tolerant taxa present.	50–59 40-49	<60 Variable
E	Severely impaired. Only tolerant taxa present.	20-39	Variable
F	Critically impaired. Very few tolerant taxa present.	0-19	Variable

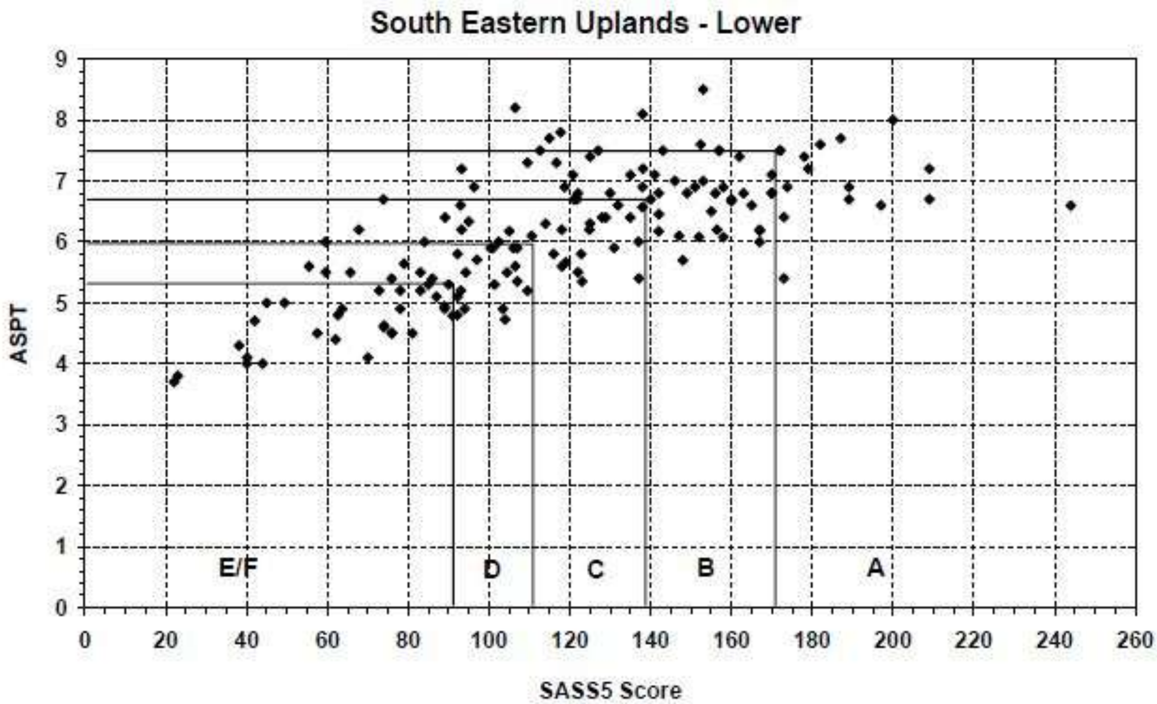


Figure 4: SASS5 Classification using biological bands calculated form percentiles for the South Eastern Uplands Aquatic Ecoregion - Lower, Dallas, 2007. This will be applied to the assessment sites on the larger Tsitsa River.

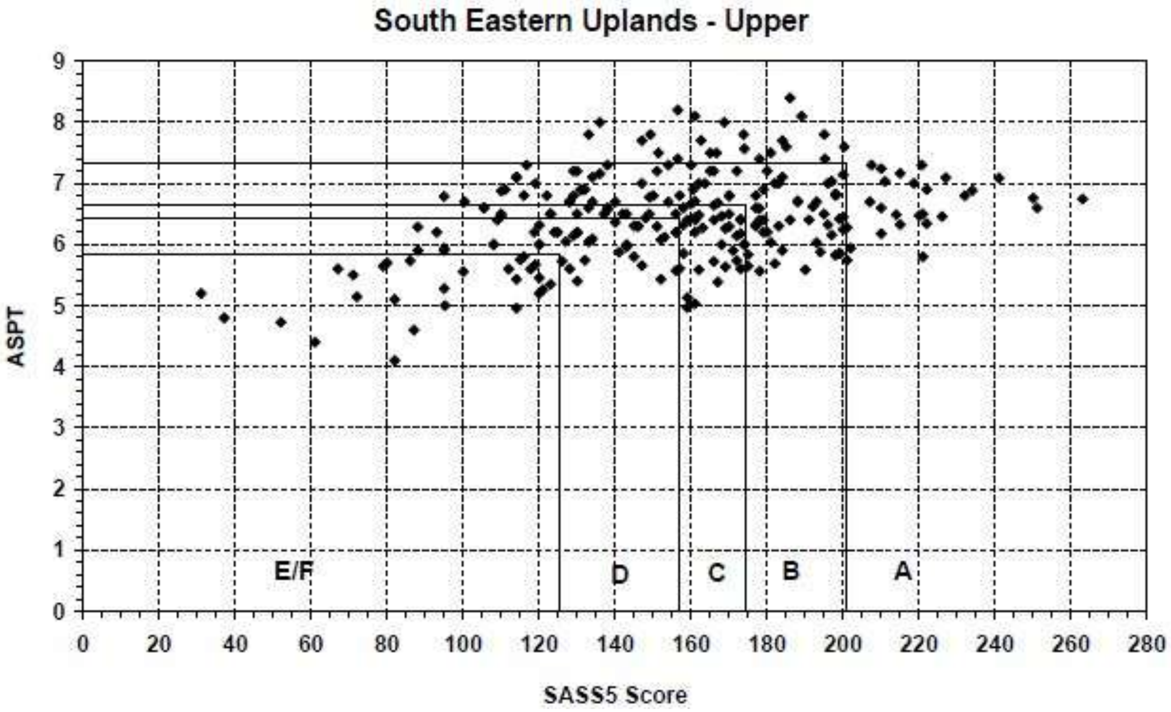


Figure 5: SASS5 Classification using biological bands calculated form percentiles for the South Eastern Uplands Aquatic Ecoregion - Upper, Dallas, 2007. This will be applied to the assessment sites on the smaller tributaries of the Tsitsa River.

3.2.7 Aquatic Macro-Invertebrates: Macro-invertebrate Response Assessment Index (MIRAI)

The four major components of a stream system that determine productivity, with particular reference to aquatic organisms, are flow regime, physical habitat structure, water quality and energy inputs. An interplay between these factors (particularly habitat and availability of food sources) result in the discontinuous, patchy distribution pattern of aquatic macro-invertebrate populations. As such aquatic invertebrates shall respond to habitat changes (i.e. changes in driver conditions).

To relate drivers to such changes in habitat and aquatic invertebrate condition, two key elements are required. Firstly habitat preferences and requirements for each taxa present should be obtained. As such reference conditions can be established against which any response to drivers can be measured. Secondly habitat features should be evaluated in terms of suitability and the requirements mentioned in the first point. As a result expected and actual patterns can be evaluated to achieve an Ecostatus Category (EC) rating.

Based on the three key requirements, the MIRAI provides an approach to deriving and interpreting aquatic invertebrate response to driver changes. The index has been applied to all sites following methodology described by Thirion (2007). Aquatic macro-invertebrates expected at each point were derived from data on macro-invertebrate families present within the entire study area at the time of assessment. Families collected from all sites were listed together. This list was then applied as macro-invertebrate families expected at each of the respective sites.
Given the homogeneity in terms of habitat types within the Tsitsa River system as well as the intact ecology of the system this approach is deemed acceptable.

3.2.8 Fish biota: Habitat Cover Rating (HCR) and Fish Habitat Assessment (FHA)

This approach was developed to assess habitats according to different attributes that are surmised to satisfy the habitat requirements of various fish species. At each site, the following depth-flow (df) classes are identified, namely:

- Slow (<0.3m/s), shallow (<0.5m) - Shallow pools and backwaters.
- Slow, deep (>0.5m) - Deep pools and backwaters.
- Fast (>0.3m/s), shallow - Riffles, rapids and runs.
- Fast, deep - Usually rapids and runs.

The relative contribution of each of the above mentioned classes at a site was estimated and indicated as:

0 = Absent
1 = Rare (<5%)
2 = Sparse (5-25%)
3 = Moderate (25-75%)
4 = Extensive (>75%)

For each depth-flow class, the following cover features (cf) -considered to provide fish with the necessary cover to utilise a particular flow and depth class- were investigated:

- Overhanging vegetation
- Undercut banks and root wads
- Stream substrate
- Aquatic macrophytes

The amount of cover present at each of these cover features (cf) was noted as:

0 = absent
1 = Rare/very poor (<5%)
2 = Sparse/poor (5-25%)
3 = Moderate/good (25-75%)
4 = Extensive/excellent (>75%)

The fish habitat cover rating (HCR) was calculated as follows:
The contribution of each depth-flow class at the site was calculated ($df/\Sigma df$).
For each depth-flow class, the fish cover features (cf) were summed (Σcf).
$HCR = df/\Sigma df \times \Sigma cf$.

The amount and diversity of cover available for the fish community at the selected sites was graphically expressed as habitat cover ratings (HCR) for different flow-depth classes as a stacked bar chart.

3.2.9 Fish biota: Fish Response Assessment Index (FRAI)

The FRAI (Kleynhans 2008) is based on the premise that “drivers” (environmental conditions) may cause fish stress which shall then manifest as changes in fish species assemblage.

The index employs preferences and intolerances of the reference fish assemblage, as well as the response of the actual (present) fish assemblage to particular drivers to indicate a change from reference conditions. Intolerances and preferences are divided into metric groups relating to preferences and requirements of individual species. This allows cause-effect relationships to be understood, i.e. between drivers and responses of the fish assemblage to changes in drivers. These metric groups are subsequently ranked, rated and finally integrated as a fish Ecological Category (EC) shown previously in **Figure 3**. Fish expected to occur in the system is summarised in **Table 5**.

Table 5: Intolerance ratings for naturally occurring fish species with natural ranges included in the Tsitsa River the study area (Skelton, 2001; Mlondolozi et al. 2010; Scherman et al, 2007; Kleynhans, 2003; Kleynhans, Louw and Moolman, 2007).

SPECIES NAME	COMMON NAME	INTOLE-RANCE RATING [2]	FROC [1] score	COMMENTS
Anguilla mossambica	Longfin eel	2.8	1	East coast from Kenya south to Cape Agulhas
Barbus anoplus	Chubbyhead barb	2.6	3	Widely distributed from Highveld Limpopo to upland Kwa-Zulu Natal, Transkei and the middle and upper Orange basin.
Cyprinus carpio	Carp	1.4	1	Widespread
Micropterus salmoides	Largemouth bass	2.2	1[3]	Widespread in Western and Eastern Cape coastal drainages, KwaZulu-Natal midlands and interior of the North-West and Northern Provinces, Gauteng, Mpumalanga and Free State. **Not expected to occur at the sites sampled.**

[1] FROC = Frequency of occurrence as obtained from Kleynhans *et al.* 2007

[2] Average overall intolerance rating as per Kleynhans (1999). Tolerant: 1-2; Moderately tolerant :> 2-3; Moderately Intolerant: >3-4; Intolerant: >4

[3] FROC scores not listed – allocated a score of 1.

3.3 IMPACT CRITERIA AND RATING SCALE

The impacts are rated in accordance with the Environmental Impact Assessment Regulations, 2010 and the criteria drawn from the IEM Guidelines Series, Guideline 5: Assessment of Alternatives and Impacts, published by the (DEAT, 2006) as well as the Guideline Document on Impact Significance (DEAT, 2002) as listed below.

The key issues identified during the Scoping Phase inform the terms of reference of this specialist study. Each issue consists of components that on their own or in combination with each other give rise to potential impacts, either positive or negative, from the project onto the environment or from the environment onto the project.

The significance of the potential impacts is considered before and after identified mitigation is implemented, for direct, indirect, and cumulative impacts, in the short and long term.

A description of the nature of the impact, any specific legal requirements and the stage (construction/decommissioning or operation) is given. Impacts are considered to be the same during construction and decommissioning.

The following criteria have been used to evaluate significance:

- **Nature:** This is an appraisal of the type of effect the activity is likely to have on the affected environment. The description includes what is being affected and how. The nature of the impact will be classified as positive or negative, and direct or indirect.

- **Extent and location:** This indicates the spatial area that may be affected (**Table 6**:).

Table 6: Geographical extent of impact

Rating	Extent	Description
1	Site	Impacted area is only at the site – the actual extent of the activity.
2	Local	Impacted area is limited to the site and its immediate surrounding area
3	Regional	Impacted area extends to the surrounding area, the immediate and the neighbouring properties.
4	Provincial	Impact considered of provincial importance
5	National	Impact considered of national importance – will affect entire country.

- **Duration:** This measures the lifetime of the impact (**Table 7**).

Table 7: Duration of Impact

Rating	Duration	Description
1	Short term	0 – 3 years, or length of construction period
2	Medium term	3 – 10 years
3	Long term	> 10 years, or entire operational life of project.
4	Permanent – mitigated	Mitigation measures of natural process will reduce impact – impact will remain after operational life of project.
5	Permanent – no mitigation	No mitigation measures of natural process will reduce impact after implementation – impact will remain after operational life of project.

- **Intensity/severity:** This is the degree to which the project affects or changes the environment; it includes a measure of the reversibility of impacts (**Table 8**).

Table 8: Intensity of Impact

Rating	Intensity	Description
1	Negligible	Change is slight, often not noticeable, natural functioning of environment not affected.
2	Low	Natural functioning of environment is minimally affected. Natural, cultural and social functions and processes can be reversed to their original state.
3	Medium	Environment remarkably altered, still functions, if in modified way. Negative impacts cannot be fully reversed.

4	High	Cultural and social functions and processes disturbed – potentially ceasing to function temporarily.
5	Very high	Natural, cultural and social functions and processes permanently cease, and valued, important, sensitive or vulnerable systems or communities are substantially affected. Negative impacts cannot be reversed.

- **Potential for irreplaceable loss of resources:** This is the degree to which the project will cause loss of resources that are irreplaceable (**Table 9**).

Table 9: Potential for irreplaceable loss of resources

Rating	Potential for irreplaceable loss of resources	Description
1	Low	No irreplaceable resources will be impacted.
3	Medium	Resources can be replaced, with effort.
5	High	There is no potential for replacing a particular vulnerable resource that will be impacted.

- **Probability:** This is the likelihood or the chances that the impact will occur (**Table 10**).

Table 10: Probability of Impact

Rating	Probability	Description
1	Improbable	Under normal conditions, no impacts expected.
2	Low	The probability of the impact to occur is low due to its design or historic experience.
3	Medium	There is a distinct probability of the impact occurring.
4	High	It is most likely that the impact will occur
5	Definite	The impact will occur regardless of any prevention measures.

- **Confidence:** This is the level of knowledge or information available, the environmental impact practitioner or a specialist had in his/her judgement (**Table 11**).

Table 11: Confidence in level of knowledge or information

Rating	Confidence	Description
	Low	Judgement based on intuition, not knowledge / information.
	Medium	Common sense and general knowledge informs decision.
	High	Scientific / proven information informs decision.

- **Consequence:** This is calculated as extent + duration + intensity + potential impact on irreplaceable resources.

- **Significance:** The significance will be rated by combining the consequence of the impact and the probability of occurrence (i.e. consequence x probability = significance). The maximum value which can be obtained is 100 significance points (**Table 12**).

Table 12: Significance of issues (based on parameters)

Rating	Significance	Description
1-14	Very low	No action required.
15-29	Low	Impacts are within the acceptable range.
30-44	Medium-low	Impacts are within the acceptable range but should be mitigated to lower significance levels wherever possible.
45-59	Medium-high	Impacts are important and require attention; mitigation is required to reduce the negative impacts to acceptable levels.
60-80	High	Impacts are of great importance, mitigation is crucial.
81-100	Very high	Impacts are unacceptable.

- **Cumulative Impacts:** This refers to the combined, incremental effects of the impact. The possible cumulative impacts will also be considered.

- **Mitigation:** Mitigation for significant issues will be incorporated into the EMP.

3.4 LEGISLATION AND GUIDELINES CONSIDERED

National Environmental Management Act (Act 107 of 1998)

The National Environmental Management Act (Act 107 of 1998) and the associated Regulations (Listing No R. 544, No R. 545 and R. 546) as amended in June 2010, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed.

This could follow either the Basic Assessment process or the Environmental Impact Assessment (EIA) process depending on the nature of the activity and scale of the impact. In the case of this project the EIA process has been followed.

National Water Act (NWA; Act 36 of 1998)

The NWA; Act 36 of 1998 recognises that the entire ecosystem and not just the water itself in any given water resource, constitutes the resource and as such needs to be conserved. No activity may therefore take place within a watercourse unless it is authorised by the Department of Water and Sanitation (DWS).

Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from DWS in terms of Section 21 of the NWA.

GN 704 – Regulations on use of water for mining and related activities aimed at the protection of water resources, 1999

These Regulations, forming part of the NWA, were put in place in order to prevent the pollution of water resources and protect water resources in areas where mining activity is taking place from impacts generally associated with mining.
It is recommended that the proposed project complies with Regulation GN 704 of the NWA, 1998 (act no. 36 of 1998) which contains regulations on use of water for mining, including borrowing activities and related activities aimed at the protection of water resources. GN 704 states that:

No person in control of a mine or activity may:

- locate or place any residue deposit, dam, reservoir, together with any associated structure or any other facility within the 1:100 year floodline or within a horizontal distance of 100 metres from any watercourse or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on waterlogged ground, or on ground likely to become waterlogged, undermined, unstable or cracked;
- According to the above, the activity footprint must fall outside of the 1:100 year floodline of the drainage feature or 100m from the edge of the feature, whichever distance is the greatest.

4. ASSUMPTIONS AND LIMITATIONS

For purposes of SASS5 result comparisons, the following assumption was made with reference to the Dallas (2007): Smaller streams are generally more sensitive to negative disruptive effects while larger systems are more resilient. For this reason all Tsitsa River sites were assessed according to the “South Eastern Uplands Aquatic Ecoregion – Lower” reference scores, whilst the higher “South Eastern Uplands Aquatic Ecoregion – Upper” reference scores were used for all the smaller tributaries.

The following points serve to indicate the assumptions and limitations of this study.

- ***Reference conditions are unknown:*** The composition of aquatic biota in the study area, prior to major disturbance, is unknown. For this reason, reference conditions are hypothetical, and are based on professional judgement and/or inferred from limited data available.
- ***Temporal variability:*** The data presented in this report are based on two site visits, undertaken in late autumn (April 2014) and mid-winter (June 2014). The effects of natural seasonal and long term variation in the ecological conditions and aquatic biota found in the streams are, therefore, unknown.
- ***Ecological assessment timing:*** *A*quatic and terrestrial ecosystems are dynamic and complex. It is likely that aspects, some of which may be important, could have been overlooked. A more reliable assessment of the biota would require seasonal sampling, with sampling being undertaken under both low flow and high flow conditions.
- ***Size of the Tsitsa River:*** The Tsitsa River is a large river with some areas comprising of deep pools. Deep pools are difficult to comprehensively sample for fish and benthic aquatic taxa. This, combined with the season when fish are known to hold in deeper pools where water temperatures are more stable, means that some aspects of the ecology of the Tsitsa River will not have been comprehensively assessed.

5. DESCRIPTION OF THE AFFECTED ENVIRONMENT

5.1 RESULTS OF ECOREGIONS LITERATURE REVIEW

When assessing the ecology of any area (aquatic or terrestrial), it is important to know which ecoregion the area is located within. This knowledge allows for improved interpretation of data to be made, since reference information and representative species lists are often available on this level of assessment, which aids in guiding the assessment.

The study area falls within the South Eastern Uplands Aquatic Ecoregion and the Mzimvubu to Kieskamma Management Area (WMA). Quaternary catchment database (Kleynhans 1999) was used as reference for the catchment of concern in order to define the EIS, PEMC and DEMC. **Figures 6 to 8** indicate the aquatic ecoregion and quaternary catchments of the different developments of the study area.

The Lalini Dam is located within the T35L and T35K Quaternary Catchments **(Figure 6)**, whilst the Ntabelanga Dam and road upgrades are located within the T35E quaternary catchment and the particular river resource in the area is the Upper Ntata, Mzimvubu River (**Figure 7**). The pipelines traverse over several quaternary catchments, namely T20B, T34H, T34 J, T35E, T35H and T35K (**Figure 8**).

The ecological status of these quaternary catchments are summarised in **Table 13**. From the table, it is apparent that the PES Category of the various river systems varies between PES B and PES C. Specifically, the Tsitsa River is classified as a PES Category B river, whilst the Inxu is considered to be in a PES Category C. All systems are considered to have a ‘moderate’ Ecological Importance (EI) whilst the Ecological Sensitivity (ES) varies between High to Medium sensitivity. The Tsitsa River is considered to be of moderate sensitivity whilst the Inxu River is deemed to be highly sensitive. The default Ecological Class (EC) of the river systems in these quaternary catchments, based on the median PES and highest of EI or ES means is considered to be either a Class B or a Class C. The Tsitsa River is deemed to be a Class C, and the Inxu is deemed to be a Class B system.

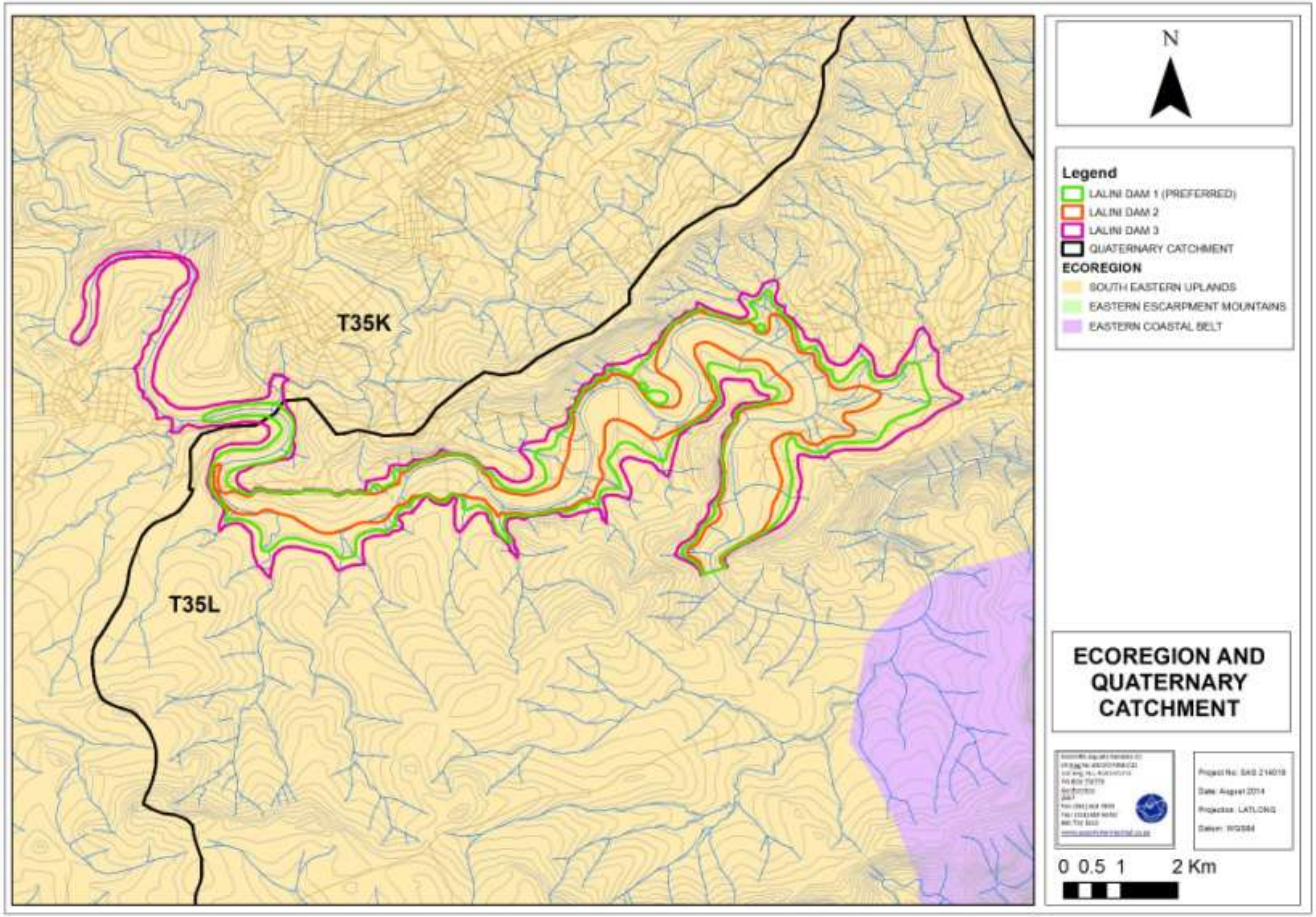


Figure 6: Aquatic Ecoregion and quaternary catchment associated with the Lalini Dam.

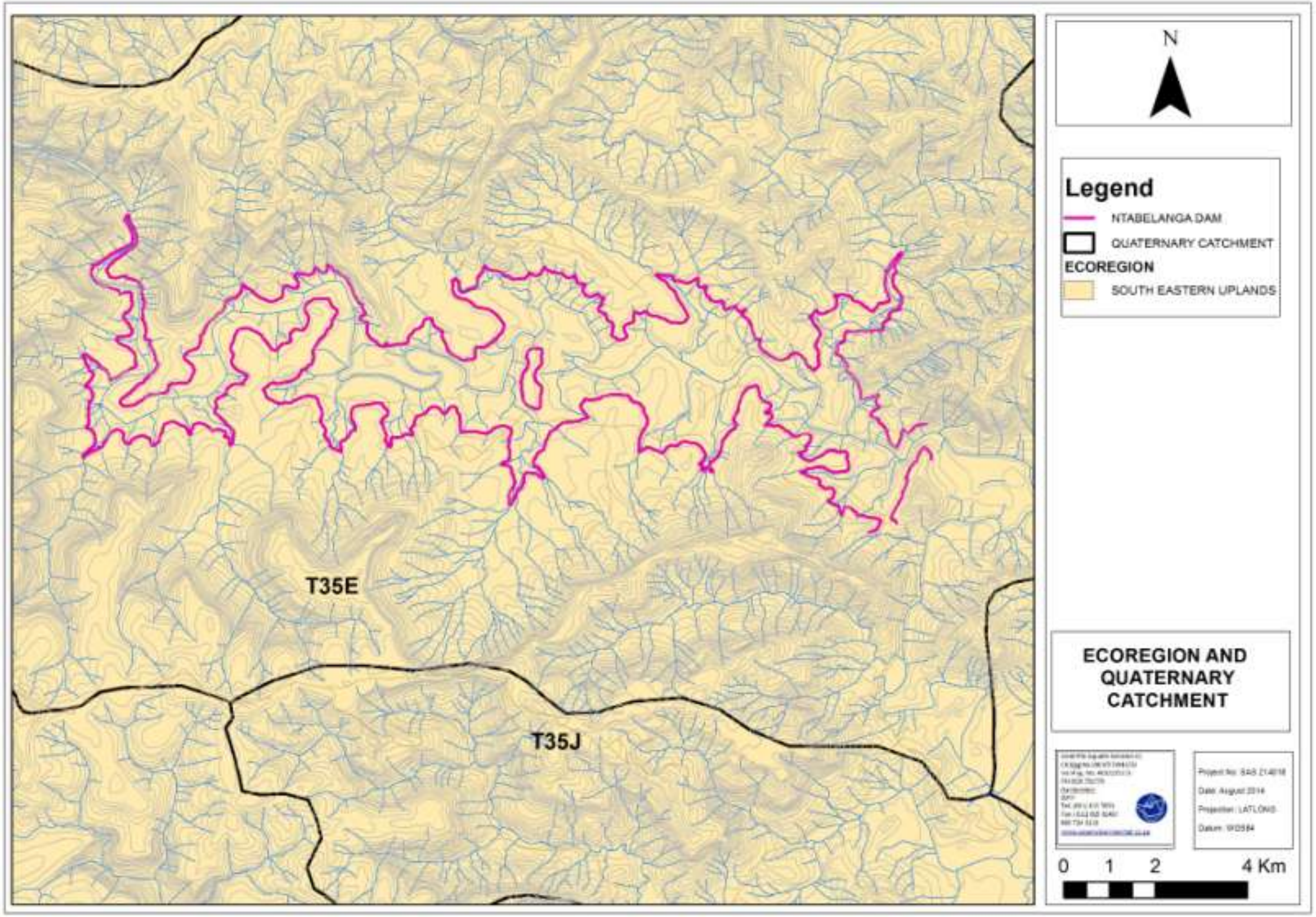


Figure 7: Ecoregion and quaternary catchment associated with the Ntabelanga Dam and the road upgrades.

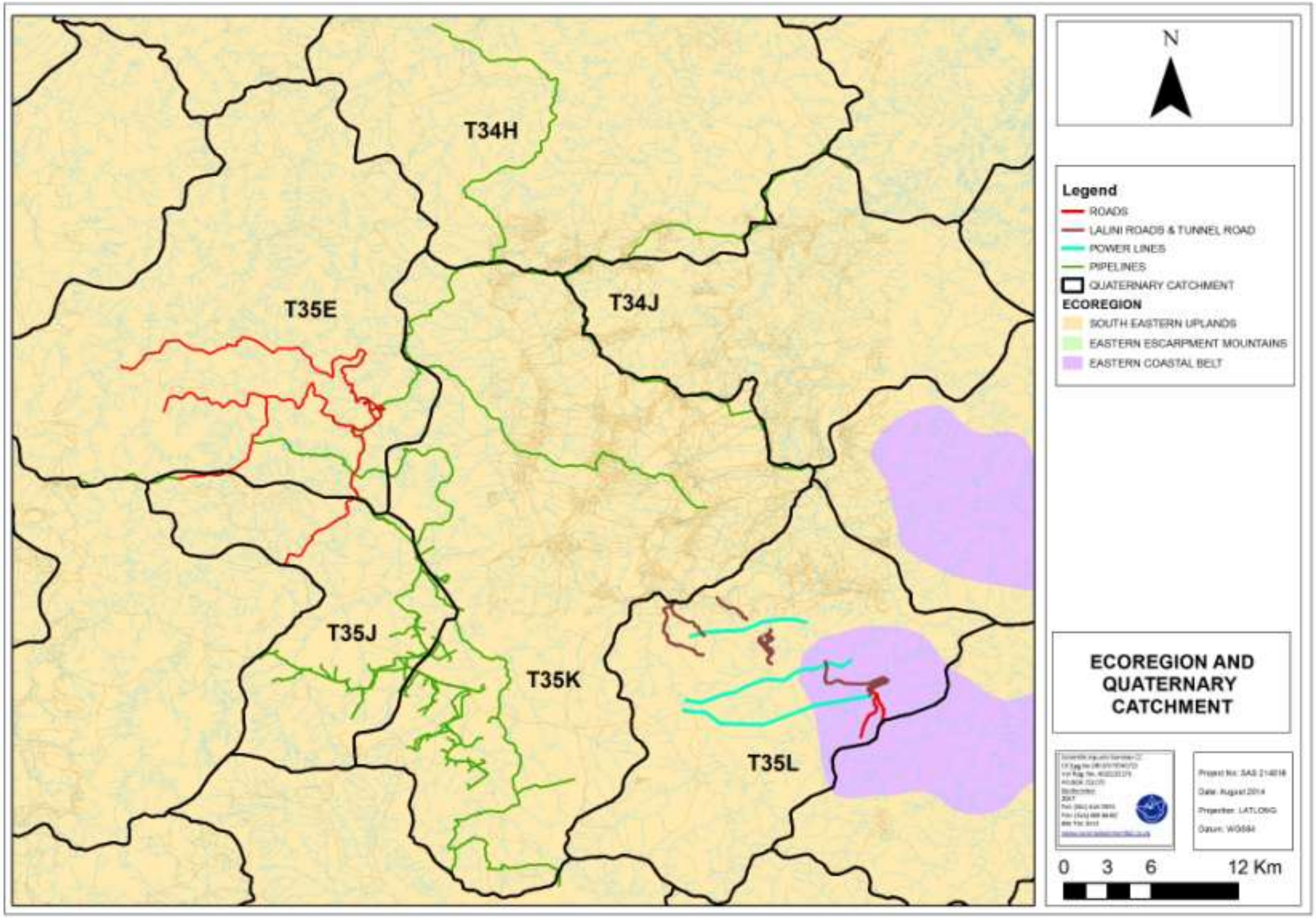


Figure 8: Ecoregion and quaternary catchment associated with the pipelines

Table 13: Summary of the Ecological Status of the quaternary catchments associated with the study area (Kleynhans *et al*. 2007)

SQ REACH	SQR NAME	PES ASSESSED BY XPERTS? (IF TRUE="Y")	PES CATEGORY MEDIAN	MEAN EI CLASS	MEAN ES CLASS	STREAM ORDER	DEFAULT EC (BASED ON MEDIAN PES AND HIGHEST OF EI OR ES MEANS)
T34H-05598	Thina	Y	C	MODERATE	MODERATE	3,0	C
T34H-05699	Mvuzi	Y	C	MODERATE	MODERATE	1,0	C
T34H-05714	Qhanqu	Y	C	MODERATE	MODERATE	1,0	C
T34H-05738	Ngcibira	Y	B	MODERATE	MODERATE	2,0	C
T34H-05769	Tsilithwa	Y	B	MODERATE	MODERATE	2,0	C
T34H-05772	Thina	Y	B	MODERATE	MODERATE	3,0	C
T34H-05791	Tsilithwa	Y	B	MODERATE	MODERATE	1,0	C
T34H-05809	Mvumvu	Y	B	MODERATE	HIGH	1,0	B
T34H-05826	Ngcothi	Y	B	MODERATE	MODERATE	1,0	C
T34H-05838	Thina	Y	C	MODERATE	MODERATE	3,0	C
T35E-05780	Gqukunqa	Y	B	MODERATE	MODERATE	1,0	C
T35E-05908	Tsitsa	Y	B	MODERATE	MODERATE	3,0	C
T35E-05977	Tsitsa	Y	B	MODERATE	MODERATE	3,0	C
T35H-06024	Inxu	Y	C	MODERATE	HIGH	3,0	B
T35H-06053	Inxu	Y	C	MODERATE	HIGH	3,0	B
T35H-06158	Qwakele	Y	C	MODERATE	HIGH	1,0	B
T35H-06186	Umnga	Y	C	MODERATE	MODERATE	2,0	C
T35H-06240	KuNgindi	Y	B	MODERATE	MODERATE	1,0	C
T35H-06282	Umnga	Y	B	MODERATE	MODERATE	1,0	C
T35J-06088	Inxu	Y	C	MODERATE	HIGH	3,0	B
T35J-06106	Ncolosi	Y	C	MODERATE	HIGH	1,0	B
T35K-05897	Culunca	Y	B	MODERATE	HIGH	1,0	B
T35K-05904	Tyira	Y	C	MODERATE	MODERATE	1,0	C
T35K-06037	Tsitsa	Y	B	MODERATE	MODERATE	4,0	C
T35K-06098	Tsitsa	Y	B	MODERATE	MODERATE	4,0	C
T35K-06167	Xokonxa	Y	C	MODERATE	MODERATE	1,0	C
T35L-05976	Tsitsa	Y	B	MODERATE	MODERATE	4,0	C
T35L-06190	Tsitsa	Y	B	MODERATE	MODERATE	4,0	C
T35L-06226	Ngcolora	Y	C	MODERATE	MODERATE	1,0	C

5.2 AQUATIC ECOLOGICAL ASSESSMENT RESULTS FOR THE TSITSA RIVER

5.2.1 Visual Assessment – April 2014

Figure 9: Upstream view of the TS1 site on the Tsitsa River showing the rocky substrate at this point, as assessed April 2014.

Figure 10: Downstream view of the TS1 site showing the diversity of flow types present, as assessed April 2014.

Figure 11: Upstream view of the Tsitsa River (TS4) showing the diversity of depth and flow profiles at this point, as assessed April 2014.

Figure 12: A downstream view of the TS4 site in the vicinity of the proposed Ntabelanga Dam wall, as assessed April 2014.

Figure 13: Upstream view of the TS7 site on the Tsitsa River showing the excellent rocky substrate at this point, as assessed April 2014.

Figure 14: Downstream view of the TS7 site showing the diversity of flows at this point, as assessed April 2014.

Figure 15: Upstream view of the TS8 site on the excellent rocky riffles and rapids at this point, as assessed April 2014.

Figure 16: Downstream view of the TS8 site showing the deeper pools, providing cover for fish, as assessed April 2014.

Table 14: Visual description of the sites selected on the Tsitsa River as assessed during April 2014

ASPECT	TS1	TS4	TS7	TS8
Significance of the point	This site serves as a future spatial reference point for all sites further downstream in the catchment. The point also serves to indicate the condition of the Tsitsa River prior to any effects as a result of the activities of the proposed construction and flooding of the Ntabelanga Dam.	Photographs are representative of the Tsitsa River approximately 500m upstream of the proposed Ntabelanga Dam wall. The point also serves to indicate the condition of the Tsitsa River prior to any effects as a result of the activities of the proposed construction and flooding of the Ntabelanga Dam.	The site is situated on the lower reaches of the Tsitsa River near to the upper flooding point of the proposed Lalini Dam. The point also serves to indicate the condition of the Tsitsa River prior to any effects as a result of the activities of the proposed construction and flooding of the Lalini Dam.	Photographs are representative of the Tsitsa River approximately 1000m upstream of the proposed Lalini Dam wall. The point also serves to indicate the condition of the Tsitsa River prior to any effects as a result of the activities of the proposed construction and flooding of the Lalini Dam.
Surrounding features	This section of the river is located a short distance downstream of the escarpment. Upstream of this area the land is rugged and remote with relatively limited rural occupation. In the immediate vicinity of the point the area is more populated and the area consists of a typical rural setting with rural settlements and agriculture dominating the landscape.	In the immediate vicinity of the point and stretching to the TS1 point the area is relatively densely populated and the area consists of a typical rural setting with rural settlements and agriculture dominating the landscape. Some larger scale commercial agriculture occurs in this area	Areas upstream of this point are relatively densely populated and the area consists of a typical rural setting with rural settlements and agriculture dominating the landscape. The N2 roadway also crosses the Tsitsa river a short distance upstream of this point as well as a DWS gauging weir	Areas upstream of this point are relatively densely populated and the area consists of a typical rural setting with rural settlements and agriculture dominating the landscape. In the immediate vicinity of the point the area is less densely populated due to limitation on accessibility of the valley and with the Tsitsa falls lower downstream in the valley.
Riparian zone characteristics	The riparian zone along the length of this section of the Tsitsa River is generally steep and narrow due to topography of the area although in some areas the floodplain is wider. Some vegetation removal has occurred as a result of firewood collection and livestock grazing. The riparian zone at this point has not been significantly affected by alien vegetation encroachment.	The riparian zone along the length of this section of the Tsitsa River is generally steep and narrow due to topography of the area. Some vegetation removal has occurred as a result of crop cultivation and livestock grazing. The riparian zone at this point has not been significantly affected by alien vegetation encroachment.	The riparian zone along the length of this section of the Tsitsa River is generally steep and narrow due to topography of the area although in some areas the floodplain is wider. Some vegetation removal has occurred as a result of firewood collection and livestock grazing. The riparian zone at this point has not been significantly affected by alien vegetation encroachment.	The riparian zone along the length of this section of the Tsitsa River is generally steep and narrow due to topography of the area although in some areas the floodplain is wider. Little vegetation removal has occurred due to the more remote nature of this area. The riparian zone at this point has not been significantly affected by alien vegetation encroachment.
Depth and flow	The Tsitsa River was flowing strongly at this	The Tsitsa River was flowing strongly at	The Tsitsa River was flowing strongly at	The Tsitsa River was flowing strongly at

ASPECT	TS1	TS4	TS7	TS8
characteristics	point at the time of assessment. A diversity of flow was evident with very fast, fast and slow flow areas present. The river consisted mostly of shallow rapids and deeper pools and glides.	this point at the time of assessment. A diversity of flow was evident with very fast, fast and slow flow areas present. The river consisted mostly of shallow rapids and deeper pools and glides.	this point at the time of assessment. A diversity of flow was evident with very fast, fast and slow flow areas present. The river consisted mostly of shallow rapids runs and glides.	this point at the time of assessment. A diversity of flow was evident with very fast, fast and slow flow areas present. The river consisted mostly of shallow rapids and deeper pools and glides.
Water clarity	Water was very clear.	Water was very clear.	Water was very clear.	Water was very clear.
Impacts and signs of pollution	At the time of assessment no significant impacts on the instream ecology were visually evident.	At the time of assessment no significant impacts on the instream ecology were visually evident	At the time of assessment limited impacts on the instream ecology were visually evident.	At the time of assessment limited impacts on the instream ecology were visually evident.

5.2.2 Visual Assessment – June 2014

Figure 17: Upstream view of the TS1 site on the Tsitsa River as assessed June 2014, showing the rocky substrate at this point and slightly lower flow compared to April 2014.

Figure 18: Downstream view of the TS1 site at the time of assessment in June 2014.

Figure 19: Upstream view of the Tsitsa River (TS4) as assessed in June 2014, showing the decrease in diversity of depth and flow profiles at this point, when compared to the April 2014 assessment.

Figure 20: A downstream view of the TS4 site in the vicinity of the proposed Ntabelanga dam wall, as assessed in June 2014.

Figure 21: Upstream view of the TS7 site on the Tsitsa River showing the excellent rocky substrate at this point, as assessed in June 2014.

Figure 22: Downstream view of the TS7 site as assessed in June 2014, showing the decrease in diversity of flows at this point when compared to the April 2014 assessment.

Figure 23: Upstream view of the TS8 site on the excellent rocky riffles at this point, as assessed in June 2014.

Figure 24: Downstream view of the TS8 site showing slightly deeper habitat providing cover for fish, as assessed in June 2014.

Table 15: Visual description of the sites selected on the Tsitsa River as assessed during June 2014

ASPECT	TS1	TS4	TS7	TS8
Depth and flow characteristics	The Tsitsa River exhibited lower flow at this point at the time of assessment, compared to that observed during the April 2014 assessment. Lower flow also resulted in a reduction in the diversity of flow types. Limited diversity of flow was evident with fast and slow flow areas present. The river consisted mostly of shallow rapids and glides/runs and small, shallow pools.	The Tsitsa River exhibited lower flow at this point at the time of assessment, compared to that observed during the April 2014 assessment. Lower flow also resulted in a reduction in the diversity of flow types. However, a diversity of flow was still evident with very fast, fast and slow flow areas present. The river consisted mostly of shallow rapids and deeper pools and glides.	The Tsitsa River exhibited lower flow at this point at the time of assessment, compared to that observed during the April 2014 assessment. Lower flow also resulted in a reduction in the diversity of flow types. However, a diversity of flow was evident with very fast, fast and slow flow areas present. The river consisted mostly of shallow runs and glides with interspersed rapids.	The Tsitsa River exhibited lower flow at this point at the time of assessment, compared to that observed during the April 2014 assessment. Lower flow also resulted in a reduction in the diversity of flow types. A diversity of flow was evident with very fast, fast and slow flow areas present. The river consisted mostly of shallow rapids and deeper pools and glides.
Water clarity	Water was very clear.	Water was very clear.	Water was very clear.	Water was very clear.
Impacts and signs of pollution	At the time of assessment no significant impacts on the instream ecology were visually evident.	At the time of assessment no significant impacts on the instream ecology were visually evident	At the time of assessment limited impacts on the instream ecology were visually evident.	At the time of assessment limited impacts on the instream ecology were visually evident.

5.2.3 Physico-Chemical Water Quality

Water quality variables were measured at the four points on the Tsitsa River (**Table 16, Figures 25 and 26**). TS1 represents the most upstream point and acts as upstream reference for the other sites downstream.

Table 16: Biota specific water quality data for the assessed Tsitsa River sites

Site	Description	Month	Conductivity (mS/m)	pH (pH units)	Temp (ºC)
TS1	Most upstream point on the system on the upper boundary of the project area, just prior to the location of the proposed Ntabelanga Dam and road upgrades Tsitsa River – spatial reference point	April 2014	9.0	8.78	18.6
		June 2014	5.2	7.10	14.4
TS4	Downstream site on the system at a point just above the proposed dam wall.	April 2014	14.0	8.57	20.8
		June 2014	14.2	8.10	17.3
TS7	Downstream site on the system at a point just upstream of the location of the proposed Lalini Dam full supply level.	April 2014	14.0	8.81	22.8
		June 2014	12.1	7.80	12.1
TS8	Downstream site on the system at a point just after the planned development mentioned above.	April 2014	13.0	8.79	22.8
		June 2014	12.3	7.60	20.1

The following key points on the water quality of the Tsitsa River system both upstream and in the vicinity of the proposed Mzimvubu Water Project were observed:

- The overall water quality conditions in the Tsitsa River is very good, with recorded water quality parameters similar for the two assessments;
- Between April 2014 and June 2014, EC values decreased by 42.2% at site TS1, by 10.0% at site TS7 and by 5.4% at site TS8. There was a 1.4% increase in EC between assessments at site TS4;
- Spatially there was an increase in conductivity in a downstream direction in April 2014, with electrical conductivity (EC) being 44.4% higher at site TS8 compared to TS1. For the June 2014 assessment spatial comparison between the same two points yielded an increase of 136.5% in a downstream direction;
- The increase in EC may indicate salt loading from surrounding rural settlements and agricultural activities, that may have been compounded by lower flow conditions during June 2014;

- EC recorded at the three downstream sites on the Tsitsa River (TS4, TS7 and TS8) were thus very similar, ranging between 13.0 and 14.0 in April 2014 and between 12.3 and 14.2 in June 2014. EC values at site TS1 were lower (9.0 and 5.2 respectively), which can be expected as this is the reference point located upstream of the other points assessed;
- The water quality guideline for aquatic ecosystems (DWA 1997) states that: 1) Total dissolved salts (TDS) concentrations (i.e. as indicated by the EC measurements) should not be changed by > 15 % from the normal cycles of the water body under unimpacted conditions at any time of the year; and 2) the amplitude and frequency of natural cycles in TDS concentrations should not be changed;
- When viewing upstream site TS1 as reference site, the spatial change in a downstream direction during both April 2014 and June 2014 thus exceeds the above recommendation;
- From a temporal perspective, the percentage change between April 2014 and June 2014 ranged between 1.4% and 42.2% for the various sites. The guideline recommendation was exceeded only at site TS1 (42.2% change), with percentage change at the remaining three sites varying between 1.4% and 10.0%;
- These observations indicate that seasonal variation in dissolved salt concentrations in the system vary seasonally and based on rainfall in the catchment, however dissolved salt concentrations in the system can generally be considered low;
- The construction of the dams may lead to some changes in the dissolved salts in the system with temporal cycles as well as spatial changes in salt loading being altered due to altered chemical and biological processes;
- Spatially there was a 0.1% increase in pH value in a downstream direction between sites TS1 and TS8 during April 2014. During June 2014 pH increased by 7.0% between these two points;
- The water quality guideline for aquatic ecosystems (DWA 1997) states that pH values should not be allowed to vary from the range of the background pH values for a specific site by > 5 %;
- If the upstream site TS1 pH value is considered a reference value for the downstream site TS8, the observed spatial changes in pH value are in compliance the recommended guideline for April 2014, but the change exceeded the guideline in June 2014;
- From a temporal perspective, pH decreased by between 5.5% and 19.1% at the various sites between April 2014 and June 2014, exceeding the guideline recommendation in all cases;
- The results therefore indicate that pH is variable in the system over time and some changes in pH occur along the length of the system which may be related to surrounding activities;
- The proposed dams are likely to lead to additional changes in pH due to altered biological processes in the system;
- The temperatures observed at each of the points are deemed natural for the time of year and the nature of the systems. The observed variations between the points can be attributed to diurnal variation between sampling times, altitude variation between the points and the variation in the volume of water in the river. The observed variation between the autumn and winter assessments could be expected and is considered natural seasonal variation.

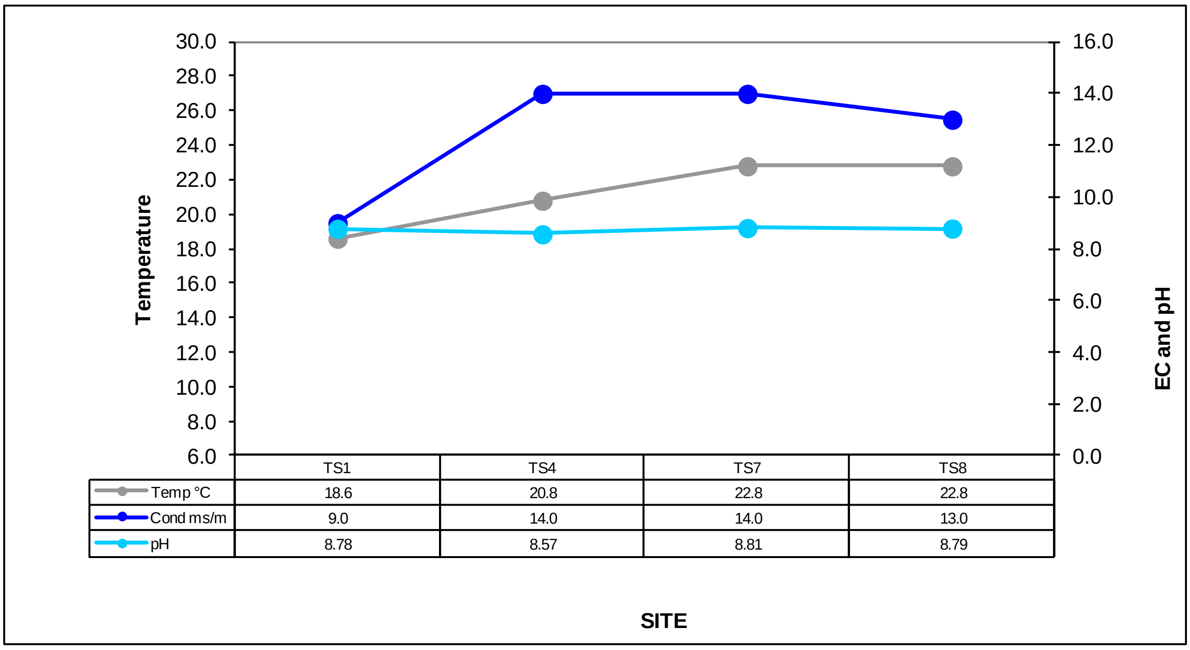


Figure 25: Physico-chemical water quality measured during April 2014 showing spatial trends

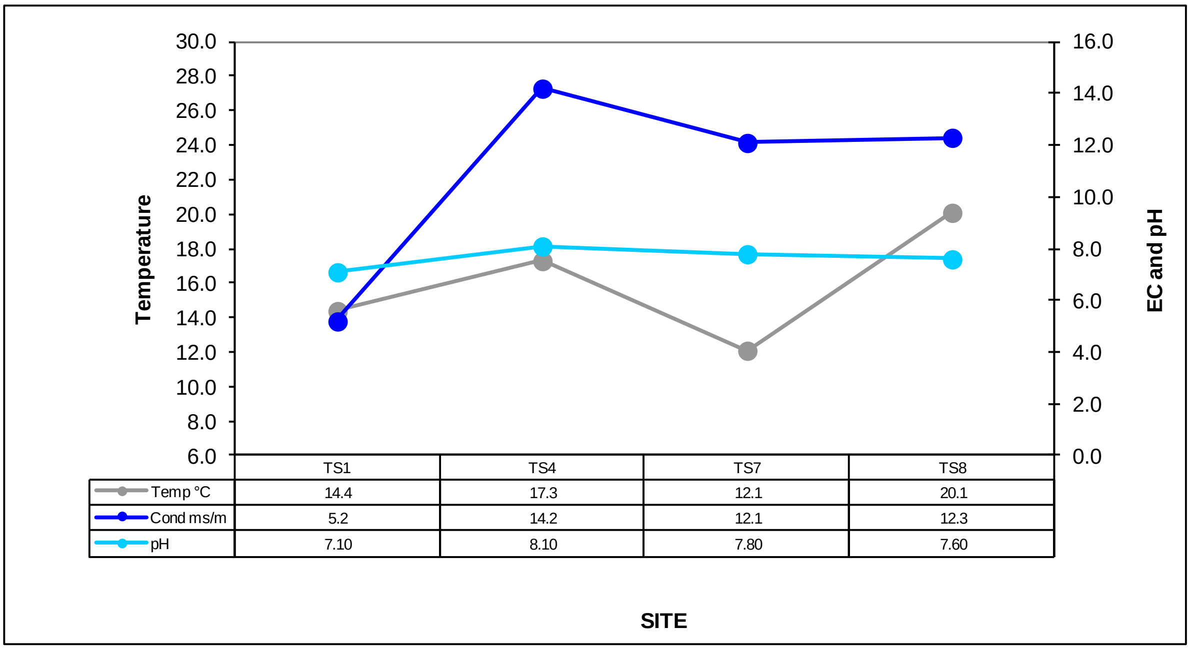


Figure 26: Physico-chemical water quality measured during June 2014 showing spatial trends

5.2.4 Intermediate Habitat Integrity Assessment (IHIA)

The full results following the application of this index are presented in **Appendix B.** This assessment was only performed during April 2014, as the index is not sensitive to small short-term changes but rather assesses longer term changes in habitat integrity.

For Tsitsa River assessment sites, small to moderate impacts were recorded for the instream zone habitat. The former relates to water abstraction (all sites), flow modification (all sites), channel modification (TS7), bed modification (all sites), water quality (all sites), exotic fauna (TS1, TS4 and TS8) and solid waste disposal (all sites).

The exotic fauna category presented with moderate impacts in all three cases. Site TS7 is most impacted in terms of instream habitat integrity. Site TS1 obtained a Class A (unmodified/natural) classification, site TS4 a Class B (largely natural) classification and sites TS7 and TS8 both obtained a C (moderately modified). The results therefore show an increasing trend of general impact on instream habitat in a downstream direction on the system.

Small to large impacts were recorded for the riparian zone. These included vegetation removal (all sites), alien encroachment (all sites) and bank erosion (all sites). Large impacts were reported for vegetation removal, alien encroachment and bank erosion. The most significant riparian zone impact at all sites was vegetation removal. Site TS1 obtained a Class B (largely natural) classification whilst the remaining three sites (TS4, TS7 and TS8) obtained a Class C (moderately modified) classification with regard to riparian habitat integrity.

Overall, sites TS1 and TS4 presented with a Class B (largely natural) classification, whilst a Class C (moderately modified) classification was obtained for sites TS7 and TS8 indicating a general deterioration in riverine habitat integrity in a downstream direction on the system.

5.2.5 Invertebrate Habitat Assessment System (IHAS)

Tables 17 and 18 are summaries of the results obtained from the application of the Invertebrate Habitat Integrity Assessment (IHAS) Index to the four river assessment sites on the Tsitsa River during April 2014 and June 2014 respectively. This index determines habitat suitability, with particular reference to the requirements of aquatic macro-invertebrates. The results obtained from this assessment will aid in interpreting the SASS5 results. IHAS scores (McMillan, 1998) are presented in **Appendix 4**.

Table 17: A summary of the results obtained from the application of and IHAS indices to the assessment sites on the Tsitsa River during April 2014.

SITE	TS1	TS4	TS7	TS8
IHAS score	77	66	71	75
IHAS Adjustment score (illustrative purposes only)	+14	+19	+15	+10
McMillan, 1998 IHAS description	Habitat diversity and structure is highly suited for supporting a diverse aquatic macro-invertebrate community under the current flow conditions.	Habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community under the current flow conditions.	Habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community under the current flow conditions.	Habitat diversity and structure is highly suited for supporting a diverse aquatic macro-invertebrate community under the current flow conditions.
Stones habitat characteristics	Adequate loose cobbles and rocks in current present. Stones out of current present.	Stone habitat in current present but suitably sized cobbles limited. Stones out of current absent.	Adequate loose cobbles and rocks in current present. Stones out of current absent. .	Adequate loose cobbles and rocks in current present. Stones out of current present.
Vegetation habitat characteristics	Bank/riparian vegetation (mix of reeds and shrubs) and fringing vegetation were present. The lack of leafy material is likely to negatively affect the diversity of the macro-invertebrate community. Aquatic vegetation was absent.	Bank/riparian vegetation (mix of reeds and shrubs) and fringing vegetation were present. The lack of leafy material is likely to negatively affect the diversity of the macro-invertebrate community. Aquatic vegetation was absent.	Bank/riparian vegetation (reeds/grass) and fringing vegetation were present. The lack of leafy material is likely to negatively affect the diversity of the macro-invertebrate community. Aquatic vegetation was absent.	Bank/riparian vegetation (mix of reeds and shrubs) and fringing vegetation were present. The lack of leafy material is likely to negatively affect the diversity of the macro-invertebrate community. Aquatic vegetation was absent.
Other habitat characteristics	No sand, gravel or mud habitats available. No algae or bedrock substrate present.	Some sand habitat available and sampled, no gravel or mud habitats available. No algae present but some bedrock substrate present.	Some sand habitat available and sampled, no gravel or mud habitats available. No algae present but some bedrock substrate present.	Some sand and gravel habitat available and sampled, no mud habitats available. No algae or bedrock.
IHAS general stream characteristics	The stream at this point has a good diversity of flow, is wide and of average depth under the current conditions. Water is clear and bank cover is good, thus limiting the potential for erosion at this point.	The stream at this point has a good diversity of flow, is wide and of average depth under the current conditions. Water is clear and bank cover is fair, thus limiting the potential for erosion at this point.	The stream at this point has a good diversity of flow, is wide and of average depth under the current conditions. Water is clear and bank cover is fair, thus limiting the potential for erosion at this point to some degree.	The stream at this point has a good diversity of flow, is wide and of average depth under the current conditions. Water is clear and bank cover is fair, thus limiting the potential for erosion at this point. However, some signs of erosion were evident.

Table 18: A summary of the results obtained from the application of and IHAS indices to the assessment sites on the Tsitsa River during June 2014.

SITE	TS1	TS4	TS7	TS8
IHAS score	71	65	71	76
IHAS Adjustment score (illustrative purposes only)	+11	+20	+15	+9
McMillan, 1998 IHAS description	Habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community under the current flow conditions.	Habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community under the current flow conditions.	Habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community under the current flow conditions.	Habitat diversity and structure is highly suited for supporting a diverse aquatic macro-invertebrate community under the current flow conditions.
Stones habitat characteristics	Adequate loose cobbles and rocks in current present. Stones out of current present.	Stone habitat in current present but suitably sized cobbles limited. Stones out of current absent.	Adequate loose cobbles and rocks in current present. Stones out of current absent. .	Adequate loose cobbles and rocks in current present. Stones out of current present.
Vegetation habitat characteristics	Bank/riparian vegetation (predominantly shrubs) and fringing vegetation were present. The lack of leafy material is likely to negatively affect the diversity of the macro-invertebrate community. Aquatic vegetation was absent.	Bank/riparian vegetation (mix of reeds and shrubs) and fringing vegetation were present. The lack of leafy material is likely to negatively affect the diversity of the macro-invertebrate community. Aquatic vegetation was absent.	Bank/riparian vegetation (reeds/grass) and fringing vegetation were present. The lack of leafy material is likely to negatively affect the diversity of the macro-invertebrate community. Aquatic vegetation was absent.	Bank/riparian vegetation (mix of reeds and shrubs) and fringing vegetation were present. Limited leafy material is likely to negatively affect the diversity of the macro-invertebrate community. Aquatic vegetation was absent.
Other habitat characteristics	Some sand, gravel and bedrock sampled but no mud habitats available. No algae present.	Some sand habitat available and sampled, no gravel or mud habitats available. No algae present but some bedrock substrate present.	Some sand habitat available and sampled, no gravel or mud habitats available. No algae present but some bedrock substrate present.	Some sand and gravel habitat available and sampled, no mud habitats available. No algae or bedrock.
IHAS general stream characteristics	The stream at this point has a good diversity of flow, is wide and of average depth under the current conditions. Water is clear but bank cover is poor, increasing potential for erosion at this point under current flow and environmental (winter) conditions.	The stream at this point has a good diversity of flow, is wide and of average depth under the current conditions. Water is clear and bank cover is fair, thus limiting the potential for erosion at this point.	The stream at this point has a good diversity of flow, is wide and of average depth under the current conditions. Water is clear and bank cover is fair, thus limiting the potential for erosion at this point.	The stream at this point has a good diversity of flow, is wide and of average depth under the current conditions. Water is clear and bank cover is fair, thus limiting the potential for erosion at this point. However, some signs of erosion were evident.

The following points are evident with reference to the IHAS assessments:

- Habitat limitations that may negatively impact the diversity, abundance and sensitivity of the aquatic community to some degree, include absence of aquatic vegetation, mud and gravel substrate at the majority of sites;

- However, suitable habitat in the form of ample rocky substrate indicates suitable macro-invertebrate habitat conditions at the Tsitsa River points sampled;
- The variety of flow and depth conditions present at the sites is also conducive to an increased diversity of macro-invertebrate species;
- The habitat conditions at the remaining sites on the Tsitsa River is considered to be adequate to support a diverse aquatic macro-invertebrate community.

From a temporal perspective, the IHAS score decreased slightly at sites TS1 (7.8%) and TS4 (1.5%), which can be attributed to lower flow conditions in June 2014. However, IHAS score remained unchanged at site TS7 and increased by 1.3% at site TS8.

At site TS1 lower flow conditions resulted in sand and gravel substrate becoming available for sampling in June 2014. Furthermore a lower percentage leafy material and less bank cover was observed in June 2014 compared to April 2014. This can be expected under the dry winter conditions. Lower percentage leaf cover was recorded at the majority of the other sites sampled for the same reason. Apart from the latter the IHAS variables recorded remained similar between assessments at sites TS4, TS7 and TS8.

5.2.6 Aquatic Macro-Invertebrates: South African Scoring System (SASS5)

Table 19 indicates the results obtained per biotope sampled whilst SASS5 scores are tabulated in **Tables 20 and 21**. SASS5 and ASPT score sheets (Dickens and Graham, 2001) are presented in **Appendix D**.

Table 19: Biotope specific summary of the results obtained from the application of the SASS5 index to the assessment sites on the Tsitsa River during both April 2014 and June 2014

PARAMETER	SITE	MONTH	STONES	VEGETATION	GRAVEL, SAND AND MUD	TOTAL
SASS5 Score	TS1	April 2014	85	37	0	115
Number of taxa			10	7	0	15
ASPT			9.0	5.3	0	7.7
SASS5 Score		June 2014	71	12	67	88
Number of taxa			8	2	9	12
ASPT			9.0	6.0	7.0	7.3
SASS5 Score	TS4	April 2014	85	22	36	85
Number of taxa			12	3	5	13
ASPT			7.0	7.3	7.0	6.5
SASS5 Score		June 2014	76	11	19	89
Number of taxa			11	2	4	14
ASPT			7.0	5.5	5.0	6.4
SASS5 Score	TS7	April 2014	107	21	22	116
Number of taxa			12	3	5	13
ASPT			9.0	7.0	4.0	8.9
SASS5 Score		June 2014	36	12	54	67
Number of taxa			6	3	9	12
ASPT			6.0	4.0	6.0	5.6
SASS5 Score	TS8	April 2014	87	6	14	87
Number of taxa			11	1	3	11
ASPT			8.0	6.0	5.0	7.9
SASS5 Score		June 2014	79	21	99	114
Number of taxa			10	3	13	16
ASPT			8.0	7.0	8.0	7.1

- Because of the very similar habitat, flow and water quality conditions at the sites, there is little variation in SASS5 results from a spatial perspective. During April 2014 sites T1 and T7 presented with similar SASS5 scores whilst sites TS4 and TS8 had similar SASS5 scores (**Figure 27**).
- Because of the lower flow conditions in June 2014, there were more variation between sites compared to April 2014 results. During June 2014 sites T1 and T4 presented with similar SASS5 scores. TS8 had the highest SASS5 score whilst sites TS7 had the lowest SASS5 score (**Figure 28**).

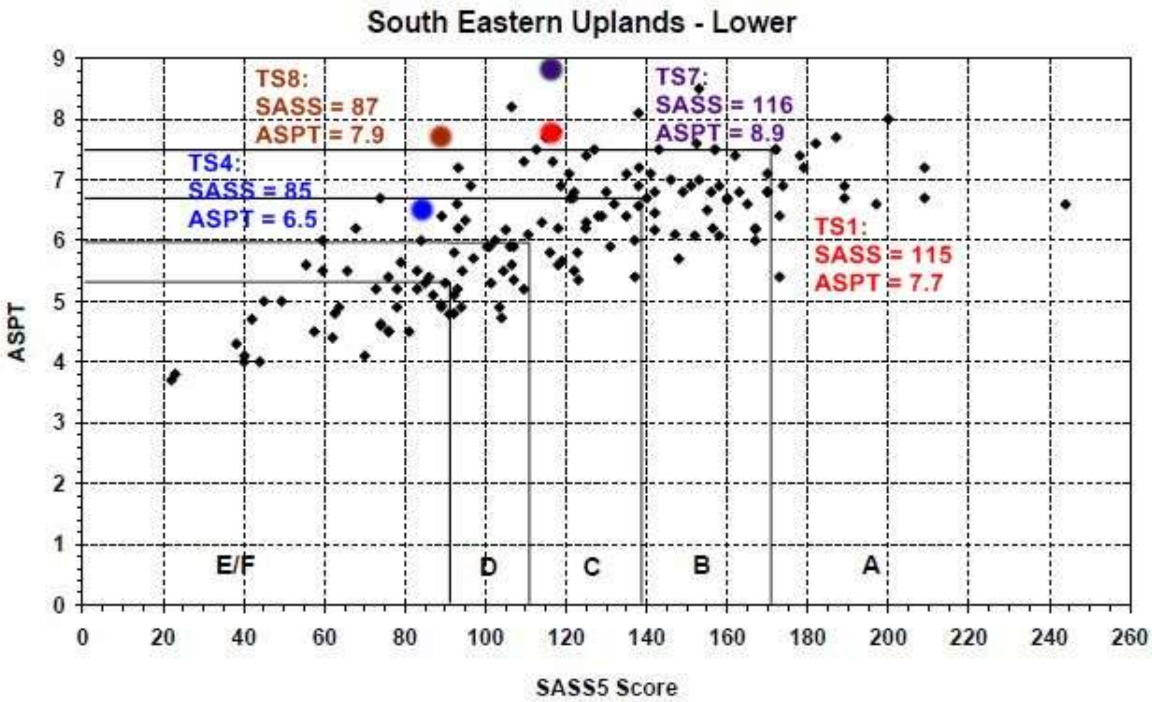


Figure 27: Visual depiction of SASS5 and ASPT scores for sites on the Tsitsa River based on the Dallas (2007) classification as recorded during April 2014.

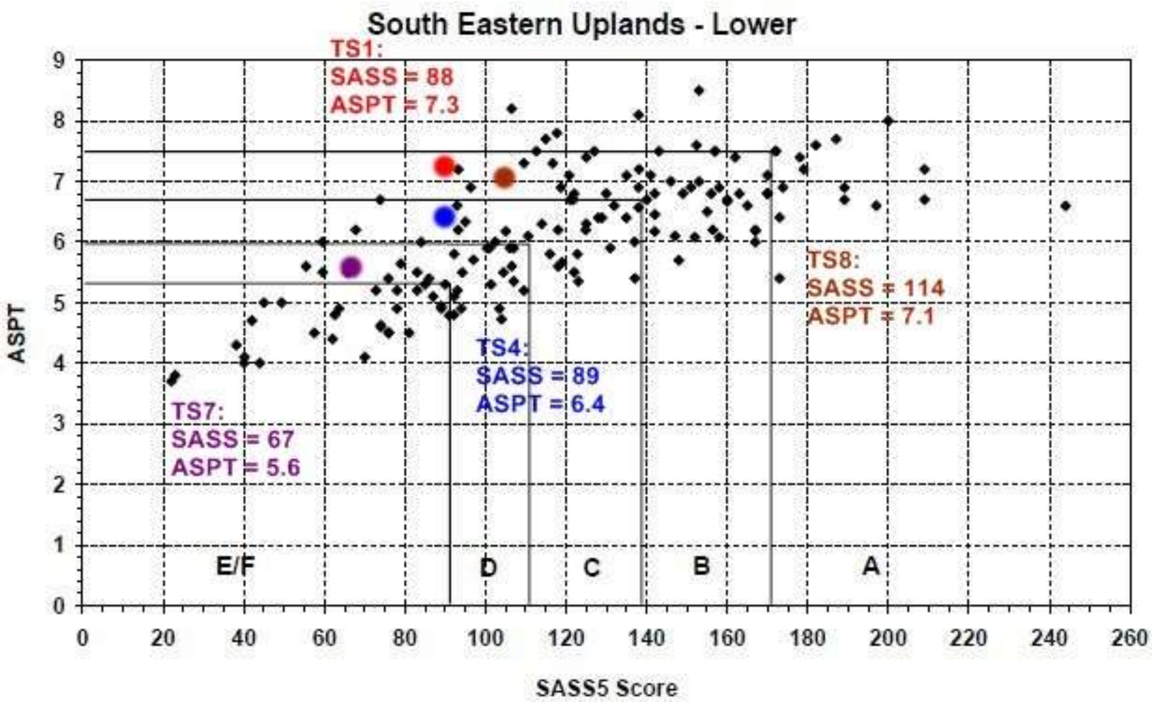


Figure 28: Visual depiction of SASS5 and ASPT scores for sites on the Tsitsa River based on the Dallas (2007) classification as recorded during June 2014.

Table 20: Summary of the results obtained from the application of the SASS5 index to the assessment sites on the Tsitsa River during April 2014

Type of Result	TS1	TS4	TS7	TS8
Biotopes sampled	Stones in current; Fringing vegetation; Stones out of current; Bedrock.	Stones in current; Fringing vegetation; Sand; Bedrock.	Stones in current; Fringing vegetation; Sand.	Stones in current; Fringing vegetation; Stones out of current; Sand; Gravel.
Sensitive taxa present	*Hydracarina; Perlidae; Heptageniidae; Oligoneuridae; Tricorythidae; Elmidae; Psephenidae.*	*Perlidae; Caenidae; Oligoneuridae; Elmidae; Psephenidae; Aeshnidae; Gomphidae.*	*Perlidae; Oligoneuridae; Prosopistomatidae; Gomphidae; Pyralidae; Elmidae; Psephenidae.*	*Perlidae; Caenidae; Oligoneuridae; Gomphidae; Elmidae; Psephenidae; Ancylidae.*
Sensitive taxa absent	*Caenidae; Aeshnidae; Gomphidae; Prosopistomatidae; Pyralidae; Leptophlebiidae; Hydraenidae.*	*Hydracarina; Heptageniidae; Tricorythidae; Prosopistomatidae; Pyralidae; Leptophlebiidae; Hydraenidae.*	*Caenidae; Aeshnidae; Hydracarina; Heptageniidae; Tricorythidae; Leptophlebiidae; Hydraenidae.*	*Prosopistomatidae; Pyralidae; Aeshnidae; Hydracarina; Heptageniidae; Tricorythidae; Leptophlebiidae; Hydraenidae.*
SASS5 score	115	85	116	87
Adjusted SASS5 score	129	104	131	97
SASS5 % of theoretical reference score*	67.6	50.0	68.2	51.2
ASPT score	7.7	6.5	8.9	7.9
ASPT % of theoretical reference score**	102.7	86.7	118.7	105.3
Dickens & Graham, 2001 SASS5 classification	C (Moderately impaired)	C (Moderately impaired)	C (Moderately impaired)	C (Moderately impaired)
Dallas 2007 classification	A	C	A	A

Table 21: Summary of the results obtained from the application of the SASS5 index to the assessment sites on the Tsitsa River during June 2014

Type of Result	TS1	TS4	TS7	TS8
Biotopes sampled	Stones in current; Fringing vegetation; Stones out of current; Sand; Gravel; Bedrock.	Stones in current; Fringing vegetation; Sand; Bedrock.	Stones in current; Fringing vegetation; Sand.	Stones in current; Fringing vegetation; Stones out of current; Sand; Gravel.
Sensitive taxa present	*Leptophlebiidae; Oligoneuridae; Tricorythidae; Aeshnidae; Caenidae.*	*Perlidae; Caenidae; Heptageniidae; Gomphidae; Psephenidae.*	*Caenidae; Prosopistomatidae; Gomphidae.*	*Heptageniidae; Oligoneuridae; Prosopistomatidae; Tricorythidae; Gomphidae.*
Sensitive taxa absent	*Hydracarina; Perlidae; Heptageniidae; Elmidae; Psephenidae; Gomphidae; Prosopistomatidae; Pyralidae; Hydraenidae.*	*Hydracarina; Oligoneuridae; Tricorythidae; Elmidae; Aeshnidae; Prosopistomatidae; Pyralidae; Leptophlebiidae; Hydraenidae.*	*Hydracarina; Perlidae; Heptageniidae; Oligoneuridae; Tricorythidae; Elmidae; Psephenidae; Aeshnidae; Pyralidae; Leptophlebiidae; Hydraenidae.*	*Hydracarina; Perlidae; Elmidae; Psephenidae; Caenidae; Aeshnidae; Pyralidae; Leptophlebiidae; Hydraenidae.*
SASS5 score	88	89	67	114
Adjusted SASS5 score	99	109	82	123
SASS5 % of theoretical reference score*	51.8	52.4	39.4	67.1
ASPT score	7.3	6.4	5.6	7.1
ASPT % of theoretical reference score**	97.3	85.3	74.7	94.7
Dickens & Graham, 2001 SASS5 classification	C (Moderately impaired)	C (Moderately impaired)	Borderline D/E (Largely to severely impaired)	C (Moderately impaired)
Dallas 2007 classification	B	C	D	B

- During the April 2014 assessment all sites could be considered to be in a Class C (moderately impaired) condition according the Dickens & Graham (2001) classification system. According to the Dallas (2007) classification system, the site TS4 was classified as Class C whilst the remaining three sites were classified as Class A (natural);
- This apparent discrepancy can be explained by the lower ASPT score recorded at site TS4;
- During the June 2014 assessment sites TS1, TS4 and TS8 can be considered to be in a Class C (moderately impaired) condition according the Dickens & Graham (2001) classification system. According to the same classification site TS7 is classified as borderline D/E (largely to severely impaired). According to the Dallas (2007) classification system, sites TS1 and TS8 were classified as Class B, site TS4 was classified as Class C whilst site TS7 was classified as Class D;
- As could be expected based on seasonal changes in flow (lower in winter), seasonal changes in SASS5 score classifications appear evident;
- This appears to have particularly impacted site TS7, where a significant decrease in ecological classification appear to have occurred between April 2014 and June 2014. This is considered to be the result of change in habitat availability resulting from lower flow. Previous riffle areas with very fast flow were no longer available, as is also shown by the percentage preference by habitat type (**Table 22**) discussed in the MIRAI section that is to follow;
- The results indicate that there is substantial spatial and temporal variation in the system, however all the variation in the system can be considered to be natural variation. No highly significant impacts are deemed likely to occur in this segment of the Tsitsa river which will lead to a fundamental change in the aquatic macro-invertebrate community integrity of the system;
- Because of the largely natural conditions evident at these sites, special care should be taken during the construction phase, but also during design and operational procedures to limit the impact on the Tsitsa River;
- Due to the natural conditions in the system the aquatic macro-invertebrate community is reliant on fast flowing, turbulent, well oxygenated, clear water flowing over a rocky substrate. The proposed impoundments will lead to the complete loss of this habitat over extensive lengths of the Tsitsa River and will therefore have a very significant impact on the aquatic macro-invertebrate community in this segment of the system;
- The significance of the impact on the areas below the two dams will depend on how water is released from the systems and how instream flows within the system are maintained, but some level of impact on the aquatic macro-invertebrate community is deemed definite.

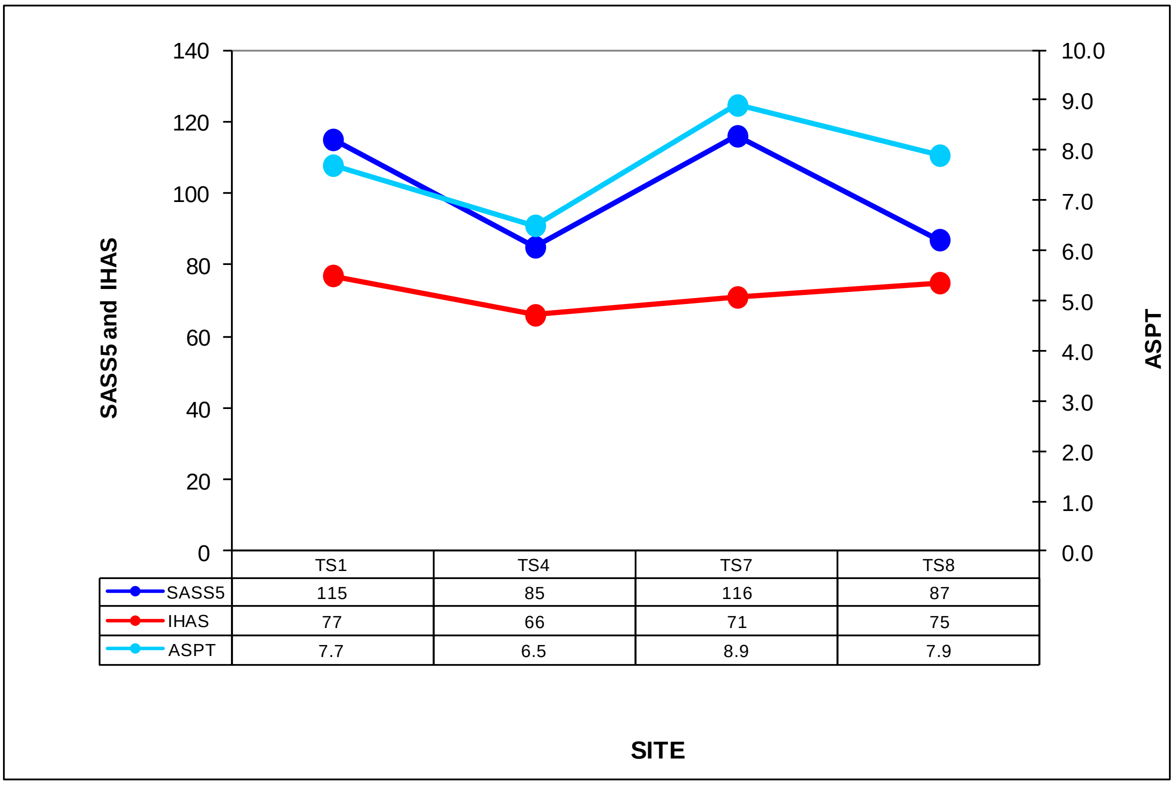


Figure 29: Visual depiction of SASS5 and ASPT scores for sites on the Tsitsa River showing spatial trends during April 2014.

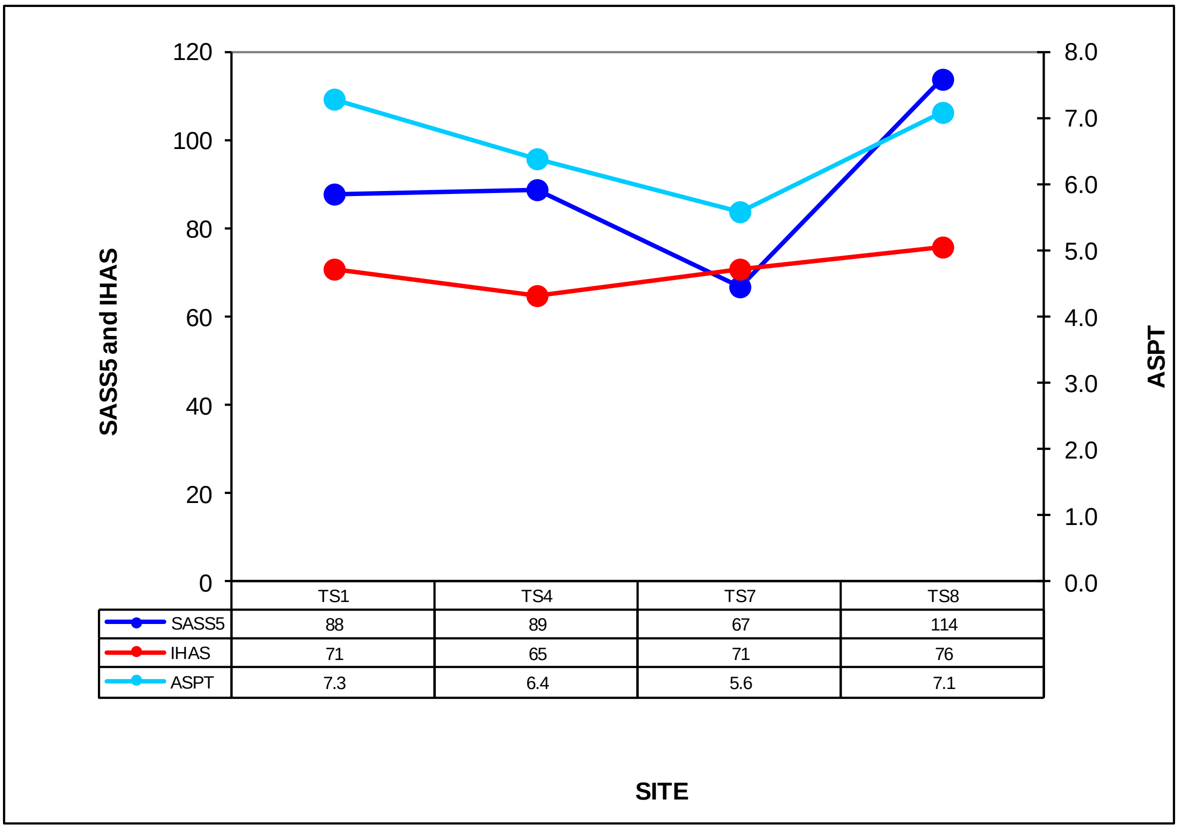


Figure 30: Visual depiction of SASS5 and ASPT scores for sites on the Tsitsa River showing spatial trends during June 2014.

5.2.7 Aquatic Macro-Invertebrates: Macro-Invertebrate Response Assessment Index (MIRAI)

During MIRAI preparation the percentage taxa occurrence per preference criteria was calculated and is summarised in **Table 22** for the **April 2014** assessment and **Table 23** for the **June 2014** assessment. This was determined by divided the number of taxa by the number of taxa expected and expressing it as a percentage.

Table 22: Percentage taxa occurrence per preference criteria for the Tsitsa River sites assessed during April 2014.

Variable	Criteria	Percentage occurrence of taxa showing preferences at each of the sites			
		TS1	TS4	TS7	TS8
Flow	Very Fast (>0.6 m/s)	75.00	62.50	75.00	62.50
	Moderately Fast (0.3-0.6 m/s)	50.00	25.00	50.00	50.00
	Slow (0.1-0.3 m/s)	66.67	33.33	33.33	33.33
	Very Slow (<0.1 m/s)	50.00	33.33	33.33	16.67
Habitat	Bedrock	0.00	0.00	0.00	100.00
	Cobbles	69.23	38.46	53.85	46.15
	Vegetation	50.00	0.00	25.00	0.00
	Gravel, Sand, Mud	25.00	50.00	50.00	50.00
	Water	50.00	33.33	16.67	16.67
Water quality	High	71.43	42.86	71.43	42.86
	Moderate	55.56	22.22	33.33	22.22
	Low	33.33	50.00	50.00	50.00
	Very Low	50.00	16.67	16.67	16.67

The preference pattern as determined during April 2014 is in agreement with the other assessments performed. Because of the very suitable rocky substrate within the system, a preference for cobbles features strongly. Whilst a variety of flow types are represented at the sites assessed, preference for moderately to very fast water features strongly. The water quality of this system is good and is reflected in the high preference exhibited for high water quality at sites TS1 and TS7. This is also reflected in the higher SASS5 scores reported from these two sites.

Table 23: Percentage taxa occurrence per preference criteria for the Tsitsa River sites assessed during June 2014.

Variable	Criteria	Percentage occurrence of taxa showing preferences at each of the sites			
		TS1	TS4	TS7	TS8
Flow	Very Fast (>0.6 m/s)	37.50	50.00	12.50	75.00
	Moderately Fast (0.3-0.6 m/s)	12.50	25.00	25.00	37.50
	Slow (0.1-0.3 m/s)	50.00	50.00	50.00	50.00
	Very Slow (<0.1 m/s)	25.00	12.50	37.50	12.50
Habitat	Bedrock	0.00	0.00	0.00	0.00
	Cobbles	38.46	30.77	7.69	53.85
	Vegetation	0.00	0.00	40.00	0.00
	Gravel, Sand, Mud	60.00	60.00	60.00	40.00
	Water	0.00	33.33	33.33	33.33
Water quality	High	37.50	25.00	25.00	50.00
	Moderate	22.22	11.11	11.11	22.22
	Low	28.57	64.29	35.71	50.00
	Very Low	28.57	14.29	57.14	42.86

The preference pattern as determined during June 2014 is in agreement with the other assessments performed. Because of the lower flow conditions in winter, the preference for slow water was higher in June compared to April. Despite the fact that very suitable rocky substrate predominates the system, a preference for less prevalent sand, mud and gravel habitats features strongly. With lower flow fewer riffle habitats would be present which explains this apparent change in preference. Whilst the water quality of this system is considered to be good, preference shifted towards lower water quality. Once again this can be largely attributed to seasonal variation relating to flow conditions and the volume of water within the system.

MIRAI scores are presented in **Table 24**, together with SASS5 scores for ease of comparison.

Table 24: Summary of the results (ecological categories) obtained from the application of the MIRAI to the assessment sites on the Tsitsa River, compared to classes awarded using SASS5.

Variable / Index	Month	TS1	TS4	TS7	TS8
Ecological category (MIRAI)	April 2014	B	C	B	C
	June 2014	C	C	C	C
Dickens and Graham (SASS5)	April 2014	C	C	C	C
	June 2014	C	C	Borderline D/E	C
Dallas (SASS5)	April 2014	A	C	A	A
	June 2014	B	C	D	B

Habitat conditions and ecological drivers at all the Tsitsa River sites were very similar. The fact that MIRAI scores at these sites were also very similar (borderline C/B in April 2014 and C in June 2014) was expected, considering that these sites are all subject to the same ecological drivers.

5.2.8 Fish Biota: Habitat Cover Rating (HCR) and Fish Habitat Assessment (FHA)

The HCR (Habitat Cover Rating) results for the Tsitsa River sites as assessed during April 2014 are provided in **Figure 31**.

Based on the depauperate fish fauna in this quaternary catchment and results obtained during the April 2014 fish sampling efforts, assessments pertaining to fish were not repeated during the June 2014 assessment. Furthermore visual assessment/observation indicated that, apart from lower water levels and slightly reduced flow, habitat cover did not change and hence the April 204 assessment results are also considered to be relevant to June 2014 conditions.

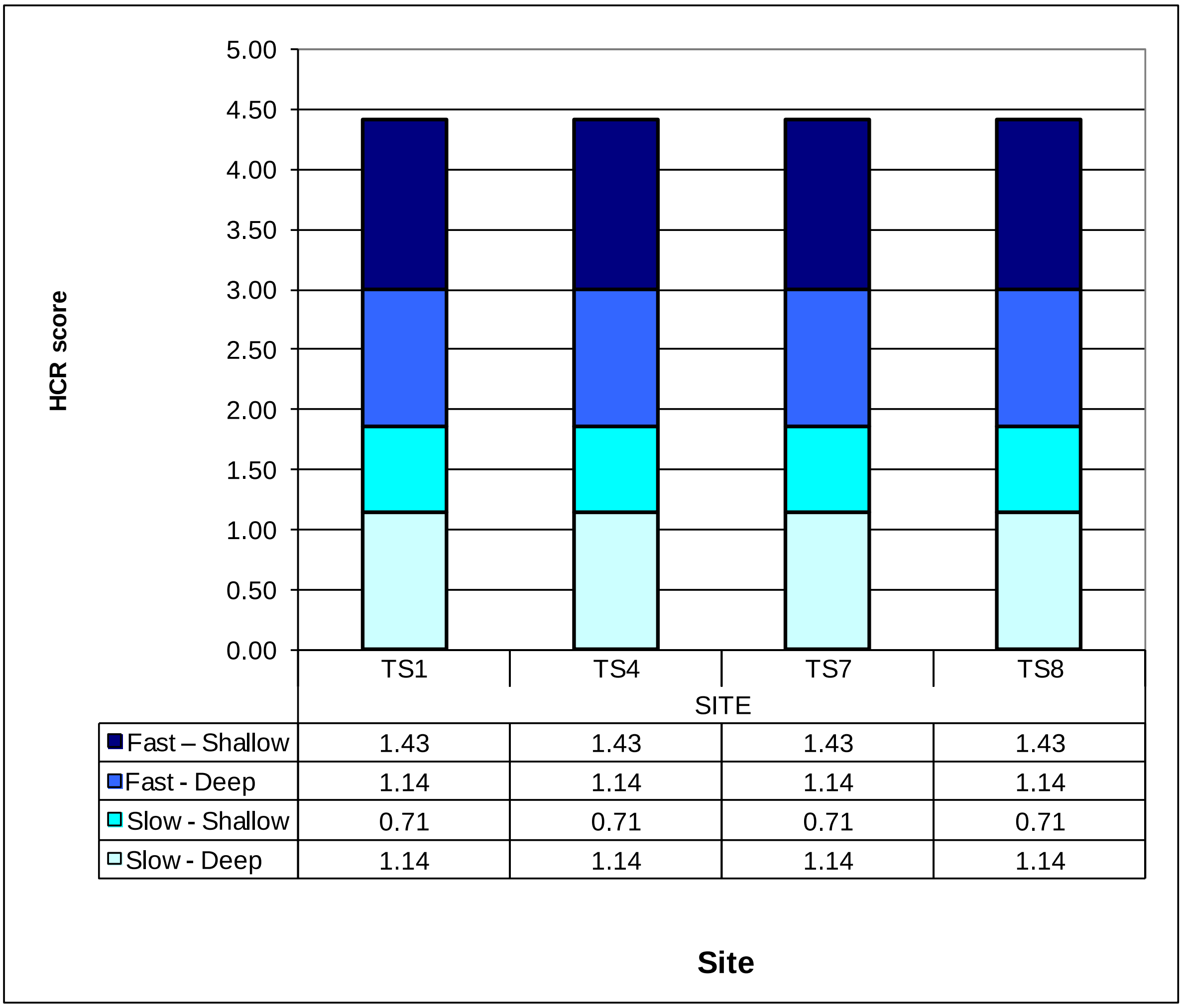


Figure 31: HCR scores for the sites assessed on the Tsitsa River as assessed during April 2014.

The sites on the Tsitsa River were all very uniform with regard to flow and depth conditions during April 2014.

During June 2014 lower flow was experienced as illustrated by the visual assessment presented previously. In the Tsitsa River this resulted in lower and slower flow as well as reduced depth at the sites assessed.

5.2.9 Fish Biota: Fish Response Assessment Index (FRAI)

The fish species expected to occur and frequency of occurrence (FROC) scores employed in the FRAI assessment were provided in **Table 5**. From this table it is clear that the fish fauna is depauperate with a naturally low diversity of fish species present.

No fish specimens were collected during sampling efforts but carp (*Cyprinus carpio*) were observed in the Tsitsa River during the April 2014 assessment. This fish species would occur at all sites assessed. Furthermore, although not collected, the longfin eel (*Anguilla mossambica*) is most likely also present at all sites (**Table 25**) and a dead specimen was observed in the vicinity of the Ntabelanga dam, caught by a local fisherman.

Table 25: Fish species observed during collections or known to occur at the various sites on the Tsitsa River as assessed during April 2014.

SPECIES NAME	Number of fish collected at sites TS1, TS4, TS7 and TS8	Frequency of occurrence score (FROC)
Cyprinus carpio	Observed only	**1**
Anguilla mossambica	Known to occur in system, observed at the Ntabelanga dam area (**Figure 32**) and sites conducive to them being present	**1**

Figure 32: Local fisherman with an *Anguilla mossambica* specimen caught in the proposed Ntabelanga Dam development area.

Table 26 summarises the EC obtained using the FRAI. For ease of comparison the EC values obtained by using the MIRAI have again been included.

Table 26: Summary of the results (ecological categories) obtained from the application of the FRAI to the GSP9 assessment site on the one site on the Mutamba River, compared to that obtained using MIRAI during the April 2014 assessment.

River assessed in April 2014	Tsitsa River
Variable / Index	**Sites TS1, TS4, TS7 and TS8**
Automated FRAI (%)	30.5
Automated EC (FRAI)	E
Refined EC (FRAI)	D/E
Ecological category (EC) (MIRAI)	C/B borderline

EC = Ecological category

From the above it is clear that the EC calculated for the FRAI does not correspond to that obtained for the MIRAI, even though changes in fish community composition would be subject to the same ecological drivers. This is firstly because of the naturally depauperate fish diversity in the quaternary catchment, but also due to the fact that no fish were collected. Only longfin eel was considered to be present in the FRAI assessment reference versus observed sheet, as carp is an alien/invasive species.

Based on the depauperate fish fauna in this quaternary catchment and results obtained during the April 2014 fish sampling efforts, sampling assessments pertaining to fish were not repeated during the June 2014 assessment.

Based on the observations of the study it is evident that the two large waterfalls on the system occurring upstream and downstream of the project area, this segment of the Tsitsa River is considered to be geographically isolated. For this reason the fish community in the system shows low diversity and sensitivity. The only fish species occurring in the system are those introduced to the system such as the exotic species *Cyprinus carpio, Micropterus Salmoides* and possibly *Onychorhynchus mykiss* and *Salmo trutta* as well as widely occurring species such as *Barbus anoplus*. None of these species except for *Cyprinus carpio* were observed in the system but the probability of these species occurring in the system is high.

The only other fish species occurring in the system was *Anguilla mossambica* which is a catadromous fish species that is known to ascend sheer waterfalls and cliffs, especially as elvers and therefore eels are the only species deemed likely to be able to colonise this segment of the Tsitsa River, except for introduction by other dispersal agents such as waterfowl.

Based on these observations it is evident that this segment of the Tsitsa River is of limited ecological importance to fish and is of limited importance to fish migration, except eels.

The proposed construction of the dams will lead to increased availability of slow deep water types which favour alien fish species such as *Cyprinus carpio* and *Micropterus Salmoides*. It is deemed highly likely that with the proposed construction of the dams the abundance of these two species will increase significantly in the area which will lead to localised impacts on aquatic community structures, fish population structures and potentially water quality regimes in the systems.

5.3 THE INXU RIVER (TS6) AND THE SMALLER UNNAMED TRIBUTARIES OF THE TSITSA RIVER (TS2, TS3, TS5 AND TS9)

A photographic record of each site was made in order to provide a visual record of the condition of each assessment site as observed during the field assessment.

The photographs taken are presented (**Figures 33 to 52**), followed by tables (**Table 27 and 28**) summarising the observations for the various criteria made during the visual assessment undertaken at each point.

5.3.1 Visual Assessment – April 2014

Figure 33: Upstream view of the TS2 site on an unnamed tributary of the Tsitsa River showing the good habitat available of the site during April 2014.

Figure 34: Downstream view of the TS2 site showing the sandy substrate present at the site as assessed April 2014.

Figure 35: Upstream view of the TS3 site on an unnamed tributary of the Tsitsa River, showing the limited habitat and cover in the system at this point as assessed in April 2014.

Figure 36: Downstream view of the TS3 site on an unnamed tributary of the Tsitsa River assessed April 2014

 **Figure 37: Upstream view of the TS5 site on an unnamed tributary of the Tsitsa River showing the diversity of habitat and cover at the point.**	 **Figure 38: Downstream view of the TS5 site on an unnamed tributary of the Tsitsa River showing the good flow in the system at the time of assessment.**
 **Figure 39: Upstream view of the TS6 site on the Inxu River showing the dominance of sandy substrate at the point.**	 **Figure 40: Downstream view of the TS6 site on the Inxu River showing the slow laminar flow at the point.**

Figure 41: Upstream view of the TS9 site on an unnamed tributary of the Tsitsa River showing the good rocky substrate at this point.

Figure 42: Downstream view of the TS9 site on an unnamed tributary of the Tsitsa River showing the limited flow at the point.

5.3.2 Visual Assessment – June 2014

Figure 43: Upstream view of the TS2 site on an unnamed tributary of the Tsitsa River showing the good habitat available despite slightly lower flow conditions during June 2014.

Figure 44: Downstream view of the TS2 site showing the sandy substrate present at the site as assessed June 2014.

Figure 45: Upstream view of the TS3 site on an unnamed tributary of the Tsitsa River showing the rocky substrate at this point. With lower flow conditions more sand and gravel substrate were also available for sampling in June 2014.

Figure 46: Downstream view of the TS3 site on an unnamed tributary of the Tsitsa River, showing lower water levels as assessed in June 2014.

Figure 47: Upstream view of the TS5 site on an unnamed tributary of the Tsitsa River showing the largely unchanged conditions (compared to April 2013) as assessed during June 2014.

Figure 48: Downstream view of the TS5 site on an unnamed tributary of the Tsitsa River showing slightly slower (compared to April 2014 assessment) flow in the system at the time of the June 2014 assessment.

Figure 49: Upstream view of the TS6 site on the Inxu River showing the dominance of sandy substrate at the point, even more pronounced during the June 2014 assessment (pictured above) when compared to April 2014, due to the lower flow conditions in winter.

Figure 50: Downstream view of the TS6 site on the Inxu River showing the lower water level and slightly slower laminar flow at the point when compared to April 2014, as assessed during June 2014.

	
Figure 51: Upstream view of the TS9 site on an unnamed tributary of the Tsitsa River showing the good rocky substrate but limited flow at this point, as assessed in June 2014.	**Figure 52: Downstream view of the TS9 site on an unnamed tributary of the Tsitsa.**

Table 27: Visual description of the sites selected on the Inxu River (TS6) and smaller unnamed tributaries of the Tsitsa River as assessed during April 2014

ASPECT	TS2	TS3	TS5	TS6	TS9
Significance of the point	The site is located on an unnamed tributary of the Tsitsa River in the upper reaches of the Ntabelanga Dam. This site serves as a future monitoring point and the current data serves to present temporal data prior to any effects as a result of the construction activities associated with the proposed dam construction with special mention of roadway construction.	The site is located on an unnamed tributary of the Tsitsa River in the middle reaches of the Ntabelanga Dam. This site serves as a future monitoring point and the current data serves to present temporal data prior to any effects as a result of the construction activities associated with the proposed dam construction with special mention of roadway construction.	The site is located on an unnamed tributary of the Tsitsa River in the vicinity of the Ntabelanga Dam. This site serves as a future monitoring point and the current data serves to present temporal data prior to any effects as a result of the construction activities associated with the proposed road upgrade to transport equipment and material to the dam construction site.	The site is located on the Inxu River, a tributary of the Tsitsa River which confluences with the Tsitsa River between the Ntabelanga and Lalini Dams. This site serves to indicate the aquatic ecology of this important system occurring between the two proposed dams.	The site is located on an unnamed tributary of the Tsitsa River in the vicinity of the town of Tsolo. This site serves as a future monitoring point and the current data serves to present temporal data prior to any effects as a result of the construction activities associated with the proposed pipeline construction and water supply network within this systems catchment.
Surrounding features	This section of the river is located in an area dominated by rural dwellings along with use of the veld for livestock grazing purposes.	This section of the river is located downstream of rural settlements at a low water bridge crossing. Some impacts on water quality from the rural settlements on this system are likely.	This section of the river is located in a rural area with some forestry and agriculture occurring in the catchment.	The Ncu River is a large River flowing through a remote rural area. In the immediate vicinity of the sampling site sand winning is taking place which is significantly affecting the riparian zone of this system	This section of the river is located downstream of several rural settlements at a bridge crossing. Some impacts on water quality from the rural settlements on this system are likely.
Riparian zone characteristics	The riparian zone along the length of this section of the stream is narrow due to the incised nature of the stream. Some vegetation removal has occurred and a loss of the woody vegetation component is evident. The riparian zone at this point is affected by erosion.	The riparian zone along the length of this section of the stream is narrow due to the incised nature of the stream. Some vegetation removal has occurred.	The riparian zone along the length of this section of the stream has been severely affected by alien vegetation encroachment. The riparian zone is narrow due to the incised nature of the system.	The riparian zone along the length of this section of the stream has been severely affected by alien vegetation encroachment and smaller impacts from livestock grazing and watering are evident. The riparian zone is narrow due to the incised nature of the system.	The riparian zone along the length of this section of the stream has been severely affected by alien vegetation encroachment. The riparian zone is narrow due to the relatively steep banks of the valley in which the system is located.
Depth and flow characteristics	The unnamed tributary River was flowing at this point and displayed some moderately fast flowing rapids but was dominated by slow flowing sections. The river alternated between rapids and glides.	The unnamed tributary River had limited flow at this point and was dominated by slow shallow flowing sections and slightly deeper pools.	The unnamed tributary River had limited flow at this point and was dominated by slow glides and runs. The river was generally shallow with limited depth and flow diversity.	The Ncu River had a low level of flow at the time of assessment and was dominated by shallow flowing glides. Flow was generally slow with limited flow variation	The unnamed tributary River had limited flow at this point and was dominated by slow glides and runs. The river was generally shallow with limited depth and flow diversity.

ASPECT	TS2	TS3	TS5	TS6	TS9
Water clarity	Water was clear.	Water was slightly discoloured, most likely as a result of algal proliferation.	Water was clear.	Water was clear.	Water was clear.
Impacts and signs of pollution	At the time of assessment no significant impacts on the in-stream ecology were visually evident	At the time of assessment no significant impacts on the in-stream ecology were visually evident although the discolouration of the water serves as a potential indication of eutrophication of the system.	At the time of assessment the most significant impact on the system observed was riparian vegetation removal. Some impact on water quality may be present leading to algal proliferation.	At the time of assessment the most significant impact on the system observed was sand winning from the river followed by impacts from alien vegetation encroachment.	At the time of assessment the most significant impact on the system observed was impacts from alien vegetation encroachment. Some impacts from impaired water quality are also deemed possible

Table 28: Visual description of the sites selected on the Inxu River (TS6) and smaller unnamed tributaries of the Tsitsa River as assessed during June 2014

ASPECT	TS2	TS3	TS5	TS6	TS9
Depth and flow characteristics	The unnamed tributary River was flowing at this point and displayed some moderately fast flowing rapids but was dominated by slow flowing sections. Water levels were lower compared to April 2014, resulting in a reduction of faster flowing rapid sections.	The unnamed tributary River had very limited flow at this point and was dominated by slow shallow flowing sections and only slightly deeper pools.	The unnamed tributary River had limited flow at this point and was dominated by slow glides and runs. The river was generally shallow with even more limited depth and flow diversity (compared to April 2014), due to lower flow conditions during June 2014.	The Inxu River had a low level of flow at the time of assessment and was dominated by shallow flowing glides. Flow was generally slow with limited flow variation, compounded by the lower water levels experienced in June 2014 compared to April 2014.	The unnamed tributary River had limited flow at this point and was dominated by slow glides and runs. The river was generally shallow with limited depth and flow diversity.
Water clarity	Water was clear.	Water was clear.	Water was clear.	Water was clear.	Water was clear.
Impacts and signs of pollution	At the time of assessment no significant impacts on the in-stream ecology were visually evident	At the time of assessment no significant impacts on the in-stream ecology were visually evident.	At the time of assessment the most significant impact on the system observed was riparian vegetation removal.	At the time of assessment the most significant impact on the system observed was sand winning from the river, compounded by low flow conditions in winter, followed by impacts from alien vegetation encroachment.	At the time of assessment the most significant impact on the system observed was impacts from alien vegetation encroachment.

As is evident from the tabulated descriptions the only difference in terms of visual assessment pertains to lower flow conditions experienced in June 2014 when compared to April 2014.

5.3.3 Physico-Chemical Water Quality

Water quality variables were measured at one point on the Inxu River (TS6) as well as four other points on smaller unnamed tributaries of the Tsitsa River (**Table 29**).

Table 29: Biota specific water quality data for the assessed Inxu River (TS6) and other smaller unnamed tributaries of the Tsitsa River (TS2, TS3, TS5 and TS9) sites

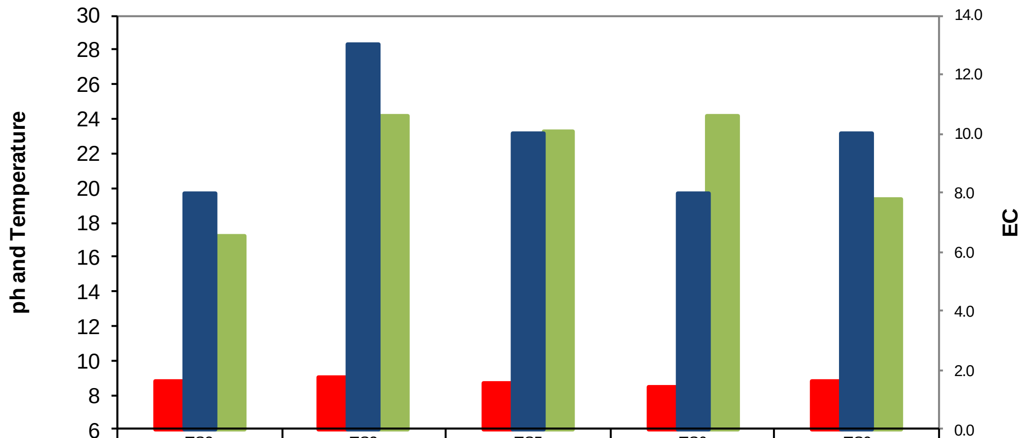
Site	Description	Month	Conductivity (mS/m)	pH (pH units)	Temp (ºC)
TS2	Unnamed tributary of the Tsitsa River upstream of the proposed Ntabelanga Dam and road upgrade developments.	April 2014	8.0	8.75	17.2
		June 2014	18.1	7.30	14.6
TS3	Unnamed tributary of the Tsitsa River upstream of the proposed developments described above.	April 2014	13.0	9.08	24.2
		June 2014	22.3	7.20	18.2
TS5	Unnamed tributary of the Tsitsa River in the vicinity of the proposed road upgrade crossing.	April 2014	10.0	8.68	23.3
		June 2014	14.3	7.70	20.6
TS6	Inxu River upstream of the proposed road upgrade developments and a major tributary of the Tsitsa River.	April 2014	8.0	8.49	24.2
		June 2014	9.2	7.10	20.1
TS9	Unnamed tributary of the Tsitsa River directly associated with the proposed pipeline development.	April 2014	10.0	8.78	19.4
		June 2014	11.7	7.8	8.8

The following key points on the water quality of the various sites both upstream and in the vicinity of the proposed Mzimvubu Water Project were observed:

- The overall water quality conditions in the Inxu River and smaller unnamed tributaries of the Tsitsa River is very good;
- As was the case with the Tsitsa River sites, EC values were consistently low at all sites assessed. However, EC values were generally higher in June 2014 when compared to April 2014. This can be attributed to lower flow conditions during winter, as represented by the June 2014 assessment), resulting in concentration of the salt load in the systems. However, potential additional salt loading from sources such as agricultural activities and rural settlements cannot be completely excluded;
- The water quality guideline for aquatic ecosystems (DWA 1997) states that: 1) Total dissolved salts (TDS) concentrations (i.e. as indicated by the EC measurements) should not be changed by > 15 % from the normal cycles of the water body under unimpacted conditions at any time of the year; and 2) the amplitude and frequency of natural cycles in TDS concentrations should not be changed;

- From a temporal perspective the recommended guideline was exceeded at all sites, with percentage increase between April 2014 and June 2014 ranging between 15% (site TS6) and 126% (site TS2);
- These results indicate that significant seasonal variation in salt concentrations in the system are evident prior to the proposed projects. Dissolved salt concentrations in the systems are however generally low and there is significant risk that the proposed irrigation activities in some of the catchments could lead to increased salinization of the systems in the nearby area
- At all sites pH values were slightly alkaline (April 2014) with a shift towards neutrality (June 2014) and once again corresponds well with that reported from the Tsitsa River;
- The water quality guideline for aquatic ecosystems (DWA 1997) states that pH values should not be allowed to vary from the range of the background pH values for a specific site by > 5 %;
- Temporally there was a decrease in pH at all sites between April 2014 and June 2014, ranging between 11.2% (site TS9) and 20.7%, exceeding the guideline recommendation in all instances indicating that there is significant seasonal variation in pH;
- The temperatures observed at each of the points are deemed natural for the time of year and the nature of the systems. The observed variations can again be attributed to diurnal variation between sampling times, the variation in the volume of water in the water bodies sampled and some level of seasonal variation in sampling times.

A graphic presentation of results is depicted in **Figures 53 and 54**.



	TS2	TS3	TS5	TS6	TS9
PH	8.75	9.08	8.68	8.49	8.78
Temp °C	17.2	24.2	23.3	24.2	19.4
Cond ms/m	8.0	13.0	10.0	8.0	10.0

SITE

Figure 53: Physico-chemical water quality variables as measured at the respective Inxu River and smaller Tsitsa River tributary sites during the April 2014 assessment.

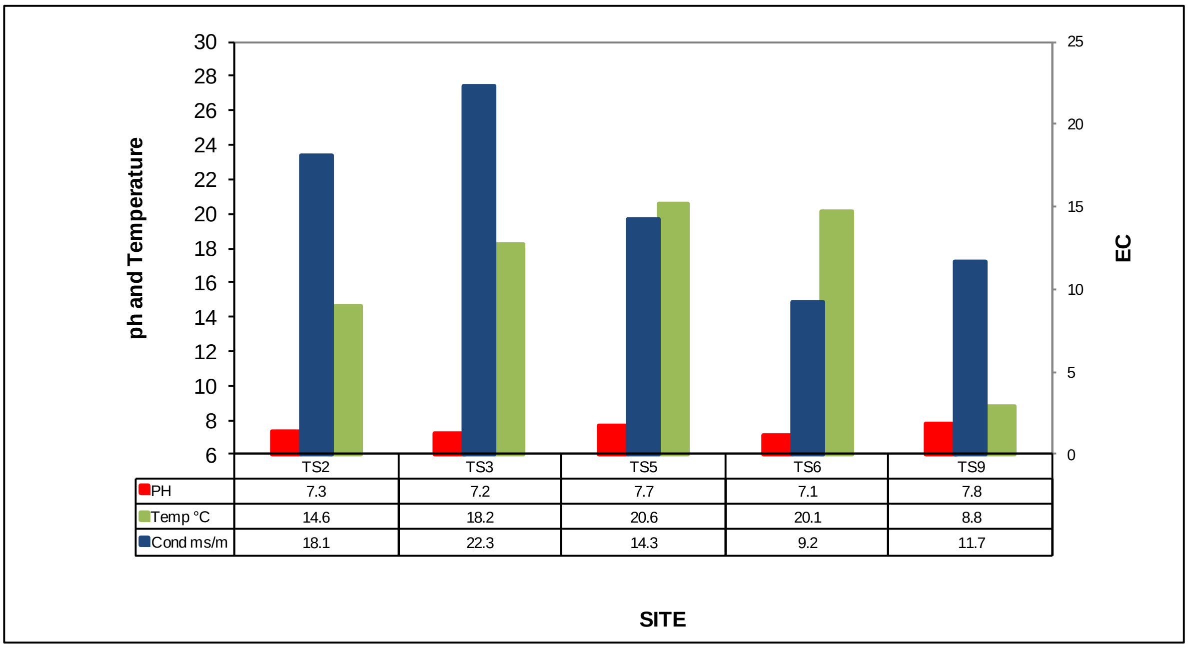


Figure 54: Physico-chemical water quality variables as measured at the respective Inxu River and smaller Tsitsa River tributary sites during June 2014.

5.3.4 Intermediate Habitat Integrity Assessment (IHIA)

The full results following the application of this index are presented in **Appendix B**. This assessment was only performed during April 2014, as the index is not sensitive to small short-term changes but rather assesses longer term changes in habitat integrity.

For Tsitsa River tributary assessment sites, small to large impacts were recorded for the in-stream zone habitat. The latter relates to channel and bed modification (TS6). At sites TS3 and TS9 moderate impacts were recorded for the same two assessment criteria. Inundation and exotic macrophytes were the only two criteria for which no impacts were recorded at any of the sites. Sites TS2 and TS3 obtained Class B (largely natural) classifications whilst the remaining sites (TS5, TS6 and TS9) obtained a Class C (moderately modified) classification.

Small to large impacts were recorded for the riparian zone. Large impacts were recorded for vegetation removal at all sites assessed. At sites TS6 and TS 9 large impacts were recorded for alien encroachment with moderate impacts recorded for the same criteria at the other sites. At sites TS2, TS3 and TS 6 large impacts were recorded for bank erosion. Moderate impact was recorded for the same criteria at site TS9 and small impact at TS5. No impacts were recorded for water abstraction, water quality or inundation at any of the sites. All sites obtained a Class C (moderately modified) classification.

Overall, sites TS3 presented with a Class B (largely natural) classification, whilst a Class C (moderately modified) classification was obtained for sites TS2, TS5, TS6 and TS9.

5.3.5 Invertebrate Habitat Assessment System (IHAS)

Table 30 and 31 summarises the results obtained from the application of the Invertebrate Habitat Integrity Assessment (IHAS) Index to the five river assessment sites on the Tsitsa River tributaries. This index determines habitat suitability, with particular reference to the requirements of aquatic macro-invertebrates. The results obtained from this assessment will aid in interpreting the SASS5 results. IHAS (McMillan, 1998) score sheets are presented in **Appendix D.**

Table 30: A summary of the results obtained from the application of and IHAS indices to the assessment sites on the Inxu River and smaller unnamed Tsitsa River tributaries during April 2014

SITE	TS2	TS3	TS5	TS6	TS9
IHAS score	67	52	44	70	66
IHAS Adjustment score (illustrative purposes only)	+23	+29	+32	+15	+25
McMillan, 1998 IHAS description	Habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community under the current flow conditions.	Habitat diversity and structure is inadequate for supporting a diverse aquatic macro-invertebrate community under the current flow conditions.	Habitat diversity and structure is inadequate for supporting a diverse aquatic macro-invertebrate community under the current flow conditions.	Habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community under the current flow conditions.	Habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community under the current flow conditions.
Stones habitat characteristics	Adequate loose cobbles and rocks in current present. Stones out of current not present.	Stone habitat present in current. No stone habitat out of current	Stone habitat present in current. No stone habitat out of current	Adequate loose cobbles and rocks in current present. Stones out of current not present.	Adequate loose cobbles and rocks in current present. Stones out of current present.
Vegetation habitat characteristics	Bank/riparian vegetation (mix of reeds and shrubs) present. Fringing vegetation absent. The lack of leafy material is likely to negatively affect the diversity of the macro-invertebrate community. Aquatic vegetation was absent.	Bank/riparian vegetation (reeds/grass) present but fringing vegetation absent. The lack of leafy material is likely to negatively affect the diversity of the macro-invertebrate community. Aquatic vegetation was absent.	Bank/riparian vegetation (reeds/grass) present but fringing vegetation absent. The lack of leafy material is likely to negatively affect the diversity of the macro-invertebrate community. Aquatic vegetation was absent.	Bank/riparian vegetation (mix of reeds and shrubs) as well as fringing vegetation present. The lack of leafy material is likely to negatively affect the diversity of the macro-invertebrate community. Aquatic vegetation was absent.	Bank/riparian vegetation (reeds/grass) present but fringing vegetation absent. The lack of leafy material is likely to negatively affect the diversity of the macro-invertebrate community. Aquatic vegetation was absent.
Other habitat characteristics	No mud habitat available but sand and gravel substrate available. No algae or bedrock substrate present.	Some sand and gravel habitat available and sampled, no mud habitat available. No algae present but some bedrock substrate present.	Some sand and gravel habitat available and sampled, no mud habitats available. No algae or bedrock substrate present.	Some sand and gravel habitat available and sampled, no mud habitats available. Isolated patches of algae but no bedrock present.	Some sand, gravel and bedrock habitat available and sampled, no mud habitats available. No algae present.
IHAS general stream characteristics	The stream at this point has a fair (mixed) diversity of	The stream at this point has poor diversity of flow	The stream at this point has a poor diversity of flow	The stream at this point has a poor diversity of flow	The stream at this point has a poor diversity of flow

SITE	TS2	TS3	TS5	TS6	TS9
	flow, is of medium width and shallow under the current conditions. Water is clear and bank cover is fair. Signs of erosion were evident.	(slow), is of medium width and shallow under the current conditions. Water is clear and bank cover is fair. Signs of erosion were evident	(slow) and is wide but shallow under the current conditions. Water is clear and bank cover is poor with signs of erosion evident.	(slow), of medium width but shallow under the current conditions. Water is clear and bank cover is fair (left bank) to poor (right bank) with signs of erosion evident.	(slow), of medium width but shallow under the current conditions. Water is clear and bank cover is fair (left bank) to poor (right bank) with signs of erosion evident.

During April 2014 (**Table 30**), the habitat diversity and structure of the Inxu River (TS6) as well as two of the other smaller Tsitsa River tributaries (TS2 and TS9) were found to be adequate for supporting a diverse macro-invertebrate community. Conditions at sites TS3 and TS5 were found to be inadequate to do the same. The lack of mud habitat and absent or reduced leaf cover on vegetation at all sites may further negatively affect diversity of invertebrate fauna

During June 2014 (**Table 31**), the exact same trend was observed as for the April 2014 assessment: habitat diversity and structure of the Inxu River (TS6) as well as two of the other smaller Tsitsa River tributaries (TS2 and TS9) were found to be adequate for supporting a diverse macro-invertebrate community. Conditions at sites TS3 and TS5 were found to be inadequate to do the same. As for April 2014 the lack of mud habitat and absent or reduced leaf cover on vegetation at all sites may further negatively affect diversity of invertebrate fauna.

Table 31: A summary of the results obtained from the application of and IHAS indices to the assessment sites on the Inxu River and smaller unnamed Tsitsa River tributaries during June 2014

SITE	TS2	TS3	TS5	TS6	TS9
IHAS score	65	52	51	69	68
IHAS Adjustment score (illustrative purposes only)	+23	+29	+27	+15	+22
McMillan, 1998 IHAS description	Habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community under the current flow conditions.	Habitat diversity and structure is inadequate for supporting a diverse aquatic macro-invertebrate community under the current flow conditions.	Habitat diversity and structure is inadequate for supporting a diverse aquatic macro-invertebrate community under the current flow conditions.	Habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community under the current flow conditions.	Habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community under the current flow conditions.
Stones habitat characteristics	Adequate loose cobbles and rocks in current present. Stones out of current not present.	Stone habitat present in current. No stone habitat out of current	Stone habitat present in current. No stone habitat out of current	Adequate loose cobbles and rocks in current present. Stones out of current not present.	Adequate loose cobbles and rocks in current present. Stones out of current present.
Vegetation habitat characteristics	Bank/riparian vegetation (mix of reeds and shrubs) present. Fringing vegetation absent. The lack of leafy material is likely to negatively affect	Bank/riparian vegetation (reeds/grass) present but fringing vegetation absent. The lack of leafy material is likely to negatively	Bank/riparian vegetation (reeds/grass) present but limited fringing vegetation sampled. The lack of leafy material is likely to negatively	Bank/riparian vegetation (mix of reeds and shrubs) as well as fringing vegetation present. However, the lack of leafy material is likely to	Bank/riparian vegetation (reeds/grass and shrubs) present and limited fringing vegetation sampled. The lack of leafy material is

SITE	TS2	TS3	TS5	TS6	TS9
	the diversity of the macro-invertebrate community. Aquatic vegetation was absent.	affect the diversity of the macro-invertebrate community. Aquatic vegetation was absent.	affect the diversity of the macro-invertebrate community. Aquatic vegetation was absent.	negatively affect the diversity of the macro-invertebrate community. Aquatic vegetation was absent.	likely to negatively affect the diversity of the macro-invertebrate community. Aquatic vegetation was absent.
Other habitat characteristics	No mud habitat available but sand and gravel substrate available. No algae or bedrock substrate present.	Some sand and gravel habitat available and sampled, no mud habitat available. No algae or bedrock substrate available for sampling.	Some sand and gravel habitat available and sampled, no mud habitats available. No algae or bedrock substrate present.	Some sand and gravel habitat available and sampled, no mud habitats available. Isolated patches of algae but no bedrock present.	Some sand, gravel and bedrock habitat available and sampled, no mud habitats available. No algae present.
IHAS general stream characteristics	The stream at this point has medium, is of medium width and shallow under the current lower flow conditions. Water is clear and bank cover is fair. Signs of erosion were evident.	The stream at this point has poor diversity of flow (slow), is of medium width and shallow under the current lower flow conditions. Water is clear and bank cover is poor (left bank) to fair (right bank). Signs of erosion were evident	The stream at this point has a poor diversity of flow (slow) and is wide but shallow under the current conditions. Water is clear and bank cover is poor with signs of erosion evident.	The stream at this point has a poor diversity of flow (slow), of medium width but shallow under the current conditions. Water is clear and bank cover is poor with signs of erosion evident.	The stream at this point has a poor diversity of flow (slow), of medium width but shallow under the current conditions. Water is clear and bank cover is fair with signs of erosion evident.

Comparing the April 2014 IHAS assessment to that performed in June 2014, the only changes pertain to lower water level and flow rates during June 2014. In many cases flow rates decreased from “mixed” to “medium” or “slow”, resulting in seasonal loss of fast flowing riffle/rapid habitat within the system during winter. Lower water levels may also impact availability of other habitat types, an example being site TS3 where bedrock was not available for sampling during the June 2014 assessment. The reduction in availability of riffle habitats with very fast to fast flowing water is expected to impact on macro-invertebrate habitat preference patterns, with associated changes in family taxa composition and prevalence. A seasonal shift toward a preference for lower, slower flow can be expected with the preference for sand, mud and gravel also increasing during winter.

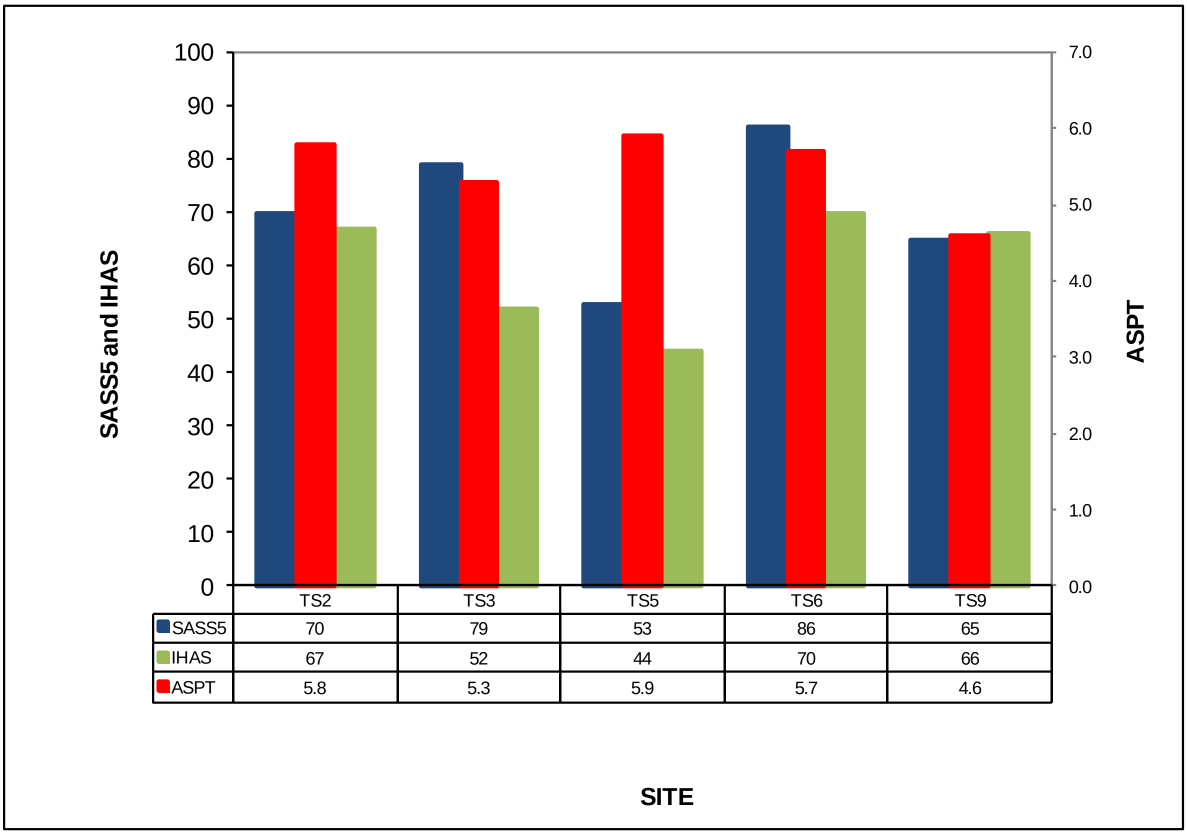
The IHAS score remained unchanged at site TS3, decreased at sites TS2 by 3.0% and TS6 by 1.4% respectively, but increased at sites TS5 by 15.9% and TS9 by 3.0% respectively. Whilst habitat scores increased in some cases, the changes in habitat preferences described above may negatively impact SASS5 scores during winter as riffle areas with fast to very fast flow predominate in summer during higher flow conditions.

5.3.6 Aquatic Macro-Invertebrates: South African Scoring System (SASS5)

Table 32 indicates the results obtained per biotope sampled whilst SASS5 scores are tabulated in **Table 33** and visually represented in **Figures 55 and 56**. SASS5 and ASPT score sheets (Dickens and Graham, 2001) are presented in **Appendix D**.

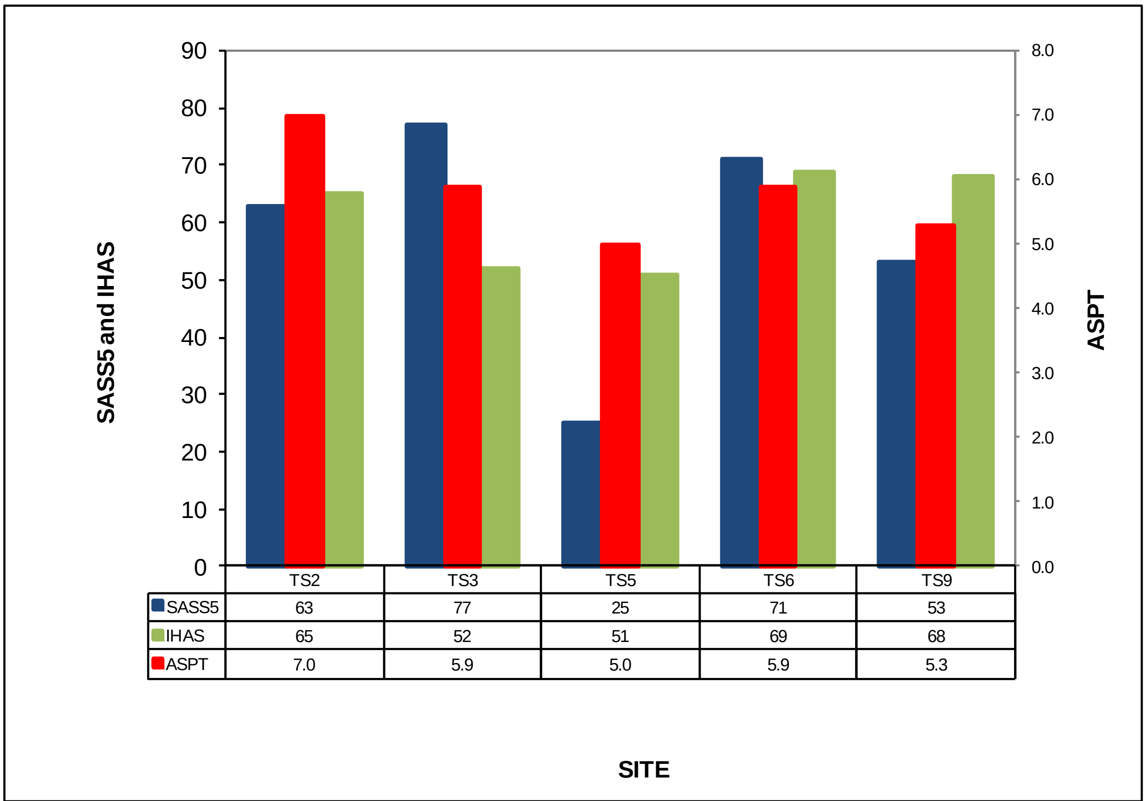
Table 32: Biotope specific summary of the results obtained from the application of the SASS5 index to the assessment sites on the Tsitsa River tributaries

PARAMETER	SITE	MONTH	STONES	VEGETATION	GRAVEL, SAND AND MUD	TOTAL
SASS5 Score	TS2	April 2014	59	0	55	70
Number of taxa			9	0	8	12
ASPT			7.0	0	7.0	5.8
SASS5 Score		June 2014	49	0	38	63
Number of taxa			6	0	6	9
ASPT			8.0	0	6.0	7.0
SASS5 Score	TS3	April 2014	75	0	35	79
Number of taxa			14	0	7	15
ASPT			5.0	0	5.0	5.3
SASS5 Score		June 2014	50	0	52	77
Number of taxa			7	0	10	13
ASPT			7.0	0	5.0	5.9
SASS5 Score	TS5	April 2014	42	20	6	53
Number of taxa			8	3	2	9
ASPT			5.0	6.7	3.0	5.9
SASS5 Score		June 2014	14	9	14	25
Number of taxa			2	2	3	5
ASPT			7.0	4.5	5.0	5.0
SASS5 Score	TS6	April 2014	71	49	26	86
Number of taxa			12	7	6	15
ASPT			6.0	7.0	4.0	5.7
SASS5 Score		June 2014	66	11	42	71
Number of taxa			11	2	7	12
ASPT			6.0	5.5	6.0	5.9
SASS5 Score	TS9	April 2014	71	49	26	86
Number of taxa			12	7	6	15
ASPT			6.0	7.0	4.0	5.7
SASS5 Score		June 2014	41	11	29	53
Number of taxa			7	2	6	10
ASPT			6.0	5.5	5.0	5.3



	TS2	TS3	TS5	TS6	TS9
SASS5	70	79	53	86	65
IHAS	67	52	44	70	66
ASPT	5.8	5.3	5.9	5.7	4.6

Figure 55: Visual depiction of SASS5 and ASPT scores for sites on the Tsitsa River tributaries as assessed April 2014.



	TS2	TS3	TS5	TS6	TS9
SASS5	63	77	25	71	53
IHAS	65	52	51	69	68
ASPT	7.0	5.9	5.0	5.9	5.3

Figure 56: Visual depiction of SASS5 and ASPT scores for sites on the Tsitsa River tributaries as assessed June 2014.

Table 33: Summary of the results obtained from the application of the SASS5 index to the assessment sites on the Tsitsa River tributaries, as assessed during April 2014.

Type of Result	TS2	TS3	TS5	TS6	TS9
Biotopes sampled	Stones in current; Sand; Gravel.	Stones in current; Sand; Gravel.	Stones in current; Sand; Gravel.	Stones in current; Fringing vegetation; Sand; Gravel.	Stones in current; Stones out of current; Sand; Gravel; Bedrock.
Sensitive taxa present	*Leptophlebiidae; Tricorythidae; Aeshnidae; Gomphidae.*	*Hydracarina; Leptophlebiidae; Tricorythidae; Aeshnidae; Gomphidae; Elmidae.*	*Perlidae; Caenidae; Aeshnidae.*	*Caenidae; Leptophlebiidae; Tricorythidae; Aeshnidae; Gomphidae; Hydraenidae;*	*Leptophlebiidae; Tricorythidae; Aeshnidae;*
Sensitive taxa absent	*Hydracarina; Perlidae; Caenidae; Heptageniidae; Oligoneuridae; Prosopistomatidae; Pyralidae; Elmidae; Hydraenidae; Psephenidae.*	*Perlidae; Caenidae; Heptageniidae; Oligoneuridae; Prosopistomatidae; Pyralidae; Hydraenidae; Psephenidae.*	*Hydracarina; Heptageniidae; Leptophlebiidae; Oligoneuridae; Prosopistomatidae; Tricorythidae; Gomphidae; Pyralidae; Elmidae; Hydraenidae; Psephenidae.*	*Hydracarina; Perlidae; Heptageniidae; Oligoneuridae; Prosopistomatidae; Pyralidae; Elmidae; Psephenidae.*	*Hydracarina; Perlidae; Caenidae; Heptageniidae; Oligoneuridae; Prosopistomatidae; Gomphidae; Pyralidae; Elmidae; Psephenidae.*
SASS5 score	70	79	53	86	65
Adjusted SASS5 score	93	108	85	101	90
SASS5 % of theoretical reference score	46.5	54.0	42.5	50.5	45.0
ASPT score	5.8	5.3	5.9	5.7	4.6
ASPT % of theoretical reference score	80.6	73.6	81.9	79.2	63.9
Dickens & Graham, 2001 SASS5 classification	D (Largely impaired)	C (Moderately impaired)	D (Largely impaired)	C (Moderately impaired)	D (Largely impaired)
Dallas 2007 classification	Borderline D and E/F	E/F	D	E/F	Borderline D and E/F

Table 34: Summary of the results obtained from the application of the SASS5 index to the assessment sites on the Tsitsa River tributaries, as assessed during June 2014.

Type of Result	TS2	TS3	TS5	TS6	TS9
Biotopes sampled	Stones in current; Sand; Gravel.	Stones in current; Sand; Gravel.	Stones in current; Fringing vegetation; Sand; Gravel.	Stones in current; Fringing vegetation; Sand; Gravel.	Stones in and out of current; Fringing vegetation; Sand; Gravel; Bedrock.
Sensitive taxa present	*Caenidae; Tricorythidae; Gomphidae.*	*Tricorythidae; Aeshnidae; Gomphidae; Psephenidae.*	*Caenidae; Aeshnidae.*	*Caenidae; Tricorythidae; Aeshnidae; Gomphidae; Psephenidae.*	*Caenidae; Tricorythidae; Aeshnidae; Gomphidae.*
Sensitive taxa absent	*Hydracarina; Perlidae; Heptageniidae; Oligoneuridae; Prosopistomatidae; Pyralidae; Elmidae; Hydraenidae; Psephenidae; Leptophlebiidae; Aeshnidae.*	*Hydracarina; Perlidae; Caenidae; Heptageniidae; Oligoneuridae; Prosopistomatidae; Pyralidae; Elmidae; Hydraenidae; Leptophlebiidae.*	*Hydracarina; Perlidae; Heptageniidae; Oligoneuridae; Prosopistomatidae; Pyralidae; Elmidae; Hydraenidae; Psephenidae; Leptophlebiidae; Tricorythidae; Gomphidae.*	*Hydracarina; Perlidae; Heptageniidae; Oligoneuridae; Prosopistomatidae; Pyralidae; Elmidae; Hydraenidae; Leptophlebiidae.*	*Hydracarina; Perlidae; Heptageniidae; Oligoneuridae; Prosopistomatidae; Pyralidae; Elmidae; Hydraenidae; Psephenidae; Leptophlebiidae.*
SASS5 score	63	77	25	71	53
Adjusted SASS5 score	86	106	52	86	75
SASS5 % of theoretical reference score	43.0	53.0	26.0	43.0	37.5
ASPT score	7.0	5.9	5.0	5.9	5.3
ASPT % of theoretical reference score	97.2	81.9	69.4	81.9	73.6
Dickens & Graham, 2001 SASS5 classification	D (Largely impaired)	C (Moderately impaired)	E (Severely impaired)	D (Largely impaired)	E (Severely impaired)
Dallas 2007 classification	B	Borderline D and E/F	E/F	Borderline D and E/F	E/F

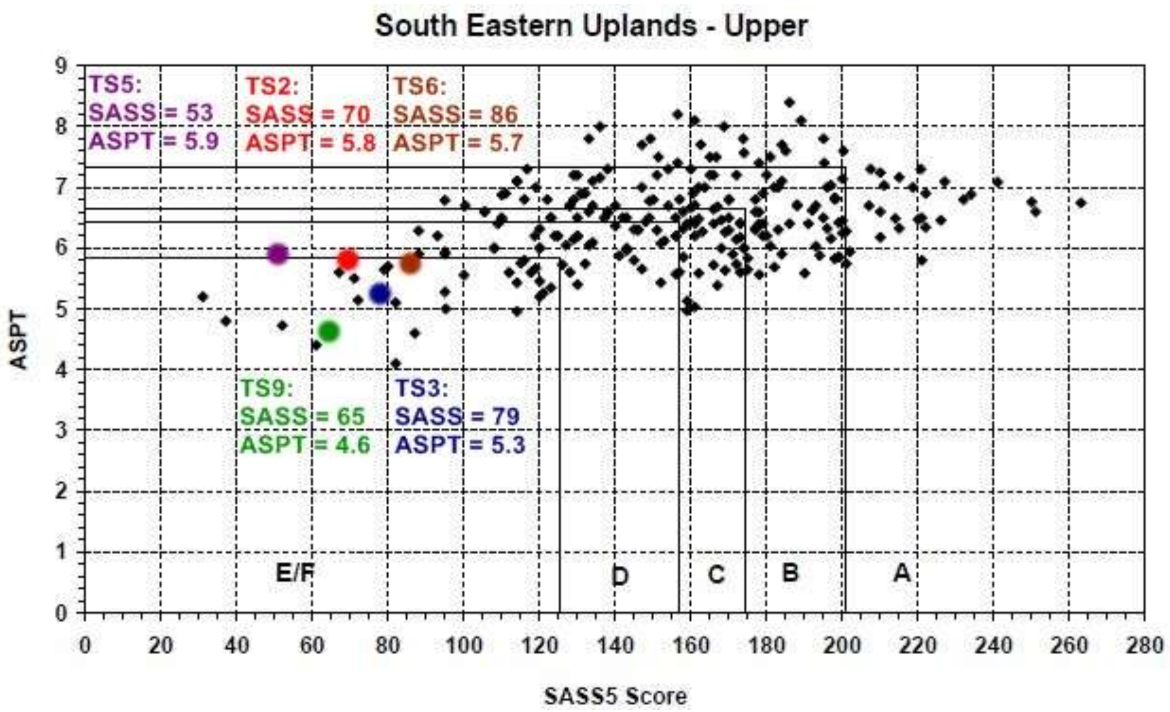


Figure 57: Visual depiction of SASS5 and ASPT scores for sites on the Tsitsa River tributaries based on the Dallas (2007) classification, as assessed during April 2014.

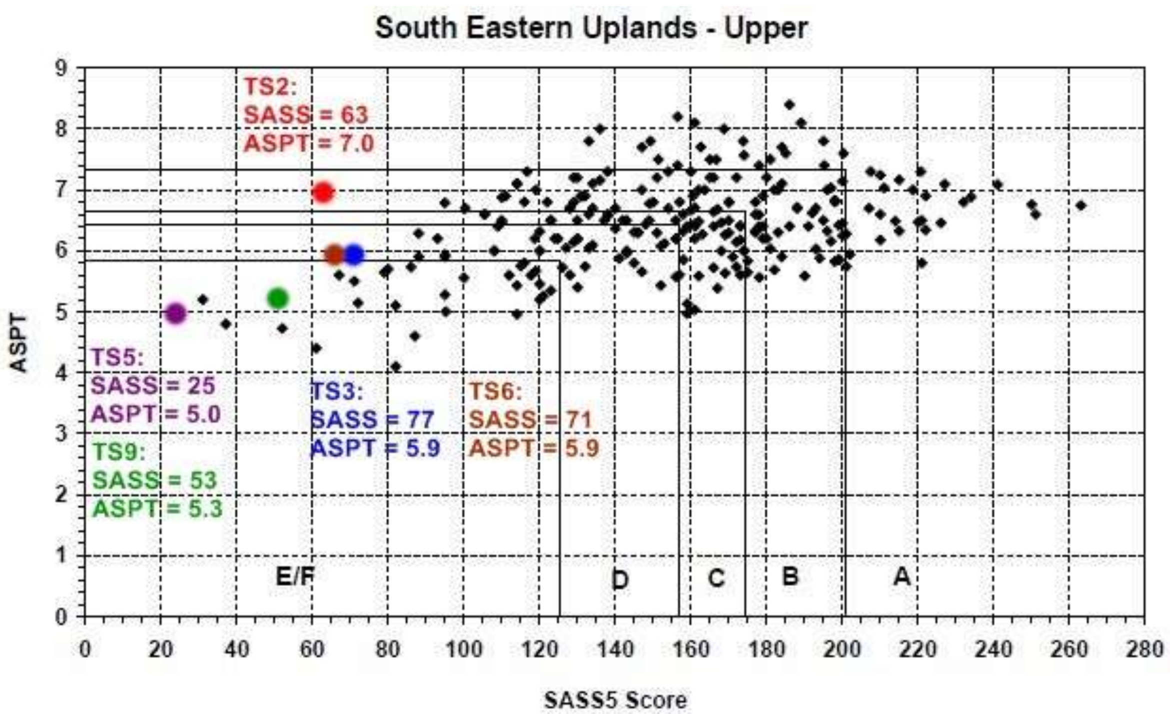


Figure 58: Visual depiction of SASS5 and ASPT scores for sites on the Tsitsa River tributaries based on the Dallas (2007) classification, as assessed during June 2014.

- Habitat limitations are likely to limit the diversity, abundance and sensitivity of the aquatic community to some degree, considering the absence of aquatic vegetation, leafy material, mud and gravel substrate at the majority of sites;

- The lack of variety of flow and depth conditions present (mostly slow and shallow) at the sites is also conducive to a decreased diversity of macro-invertebrate species. This is especially relevant to the June 2014 assessment, where lower flow conditions were encountered when compared to April 2014;
- Suitable habitat in the form of rocky substrate was present at the majority of the Tsitsa River tributaries sampled in April 2014. Exceptions were sites TS5 and TS6. The same habitat was still available during June 2014, but lower flow resulted in a reduction of available riffle habitat with fast flowing water;
- Based on the above it is clear that the lower SASS scores correlate with lower IHAS scores, when compared to that recorded for the sites on the Tsitsa River itself, especially with reference to April 2014;
- However, when comparing IHAS scores between the tributary sites, such a correlation is less evident. A point in case is site TS5, where the SASS5 score decreased by 52.8% but IHAS score actually increased by 15.9%;
- SASS 5 scores at all sites decreased by between 2.5% (site TS3) and 52.8% (site TS5). ASPT scores increased by between 3.5% and 20.7% at sites TS2, TS3, TS6 and TS9 but decreased by 15.3% at site TS5 between April 2014 and June 2014;
- Whilst seasonal changes in flow and habitat availability did contribute to the lower SASS5 scores recorded in June 2014 compared to April 2014, the effects of reduced water quality (concentration of pollutants/salt load under conditions of low flow) and negative effects from other diffuse sources (agriculture and rural settlements) cannot be completely ruled out;
- Despite the lower SASS5 scores obtained in June 2014, the generally higher ASPT scores either resulted in higher classifications (for example site TS2) or very similar classifications when compared to that obtained in April 2014;
- The Dallas (2007) classification indicated D (site TS5) or E/F (remainder of sites) conditions at all sites (**Table 33** and **Figure 57**) for April 2014. Corresponding classification in June 2014 ranged between B (site TS2) and E/F (remainder of sites) (**Table 34** and **Figure 58**).
- According to the Dickens and Graham (2001) classification, conditions at the sites in April 2014 were either impaired (classification C as recorded for sites TS3 and TS6) or largely impaired (classification D as recorded for sites TS2, TS5 and TS9) (**Tables 33 and 34**). The classifications for June 2014 were C (site TS3), D (sites TS2 and TS6) and E (sites TS5 and TS9), thus ranging from impaired to severely impaired.

5.3.7 Aquatic Macro-Invertebrates: Macro-Invertebrate Response Assessment Index (MIRAI)

During MIRAI preparation the percentage taxa occurrence per preference criteria was calculated and is summarised in **Table 35 and 36**. This was determined by divided the number of taxa by the number of taxa expected and expressing it as a percentage.

Table 35: Percentage taxa occurrence per preference criteria for the Tsitsa River tributary sites assessed during April 2014.

Variable	Criteria	Percentage occurrence of taxa showing preferences at each of the sites				
		TS2	TS3	TS5	TS6	TS9
Flow	Very Fast (>0.6 m/s)	37.50	37.50	12.50	25.00	37.50
	Moderately Fast (0.3-0.6 m/s)	25.00	37.50	0.00	62.50	25.00
	Slow (0.1-0.3 m/s)	66.67	66.67	66.67	66.67	66.67
	Very Slow (<0.1 m/s)	33.33	33.33	50.00	33.33	50.00
Habitat	Bedrock	0.00	0.00	0.00	0.00	0.00
	Cobbles	30.77	30.77	7.69	30.77	38.46
	Vegetation	0.00	0.00	0.00	50.00	0.00
	Gravel, Sand, Mud	25.00	75.00	25.00	75.00	25.00
	Water	50.00	50.00	50.00	33.33	66.67
Water quality	High	14.29	0.00	28.57	14.29	0.00
	Moderate	22.22	44.44	11.11	33.33	33.33
	Low	41.67	41.67	33.33	50.00	41.67
	Very Low	50.00	83.33	50.00	66.67	83.33

Table 36: Percentage taxa occurrence per preference criteria for the Tsitsa River tributary sites assessed during June 2014.

Variable	Criteria	Percentage occurrence of taxa showing preferences at each of the sites				
		TS2	TS3	TS5	TS6	TS9
Flow	Very Fast (>0.6 m/s)	25.00	50.00	0.00	50.00	12.50
	Moderately Fast (0.3-0.6 m/s)	25.00	25.00	0.00	25.00	25.00
	Slow (0.1-0.3 m/s)	25.00	50.00	50.00	50.00	25.00
	Very Slow (<0.1 m/s)	16.67	0.00	16.67	16.67	33.33
Habitat	Bedrock	0.00	0.00	0.00	0.00	0.00
	Cobbles	23.08	30.77	0.00	30.77	15.38
	Vegetation	0.00	0.00	0.00	0.00	0.00
	Gravel, Sand, Mud	60.00	40.00	20.00	80.00	60.00
	Water	0.00	16.67	16.67	16.67	16.67
Water quality	High	25.00	12.50	0.00	0.00	0.00
	Moderate	11.11	22.22	0.00	22.22	22.22
	Low	46.15	46.15	15.38	53.85	38.46
	Very Low	0.00	33.33	33.33	50.00	16.67

The preference patterns are in agreement with the other assessments performed. Slow conditions predominate at the majority of tributary sites, as is also indicated by observed macro-invertebrate flow preference percentage. As a result the low flow and reduced availability of fast-moving riffles did not significantly affect preference for fast water in June 2014. Habitat types between sites are more variable compared to that observed between sites on the Tsitsa River itself. For the tributaries sand and water column habitat exhibited the highest preference percentages. Whilst the water quality of the Tsitsa River tributaries considered fair, a high preference was exhibited for low water quality, with special reference to sites TS3, TS6 and TS9.

This is also reflected in the lower SASS5 scores reported from sites TS3 and TS9 in April 2014 and for all three sites in June 2014. Site TS3 also presented with the highest EC value in both April 2014 and June 2014.

MIRAI scores are presented in **Table 37,** together with SASS5 scores for ease of comparison.

Table 37: Summary of the results (ecological categories) obtained from the application of the MIRAI to the assessment sites on the Tsitsa River, compared to classes awarded using SASS5.

Variable / Index	Month	TS2	TS3	TS5	TS6	TS9
Ecological category (MIRAI)	April 2014	D	C	D	C	D
	June 2014	C	C	D	C	D
Dickens and Graham (SASS5)	April 2014	D	C	D	C	D
	June 2014	D	C	E	D	E
Dallas (SASS5)	April 2014	Borderline D and E/F	E/F	D	E/F	Borderline D and E/F
	June 2014	B	Borderline D and E/F	E/F	Borderline D and E/F	E/F

Despite the fact that habitat and flow conditions differed between the Tsitsa River tributary sites, MIRAI scores and hence ecological drivers within the larger system were very similar. The MIRAI score classifications largely corresponded with the results obtained using the SASS assessment, especially with reference to the April 2014 assessment, with either C or D classifications obtained.

With the potential developments in some of these catchments some impact on habitat, due to sedimentation and reduced water quality impacts may occur which will lead to changes in aquatic macro-invertebrate community structure. Some systems may be locally affected by proposed infrastructure upgrades with special mention of roadways and the associated bridges and therefore specific care must be applied in the design and construction of these features.

5.3.8 Fish Biota: Habitat Cover Rating (HCR) and Fish Habitat Assessment (FHA)

The HCR (Habitat Cover Rating) results for the Inxu River and smaller unnamed Tsitsa River tributary sites as assessed during April 2014 are provided in **Figure 59**.

Based on the depauperate fish fauna in this quaternary catchment and results obtained during the April 2014 fish sampling efforts, assessments pertaining to fish were not repeated during the June 2014 assessment. Furthermore visual assessment/observation indicated that, apart from lower water levels and slightly reduced flow, habitat cover did not change and hence the April 204 assessment results are also considered to be relevant to June 2014 conditions.

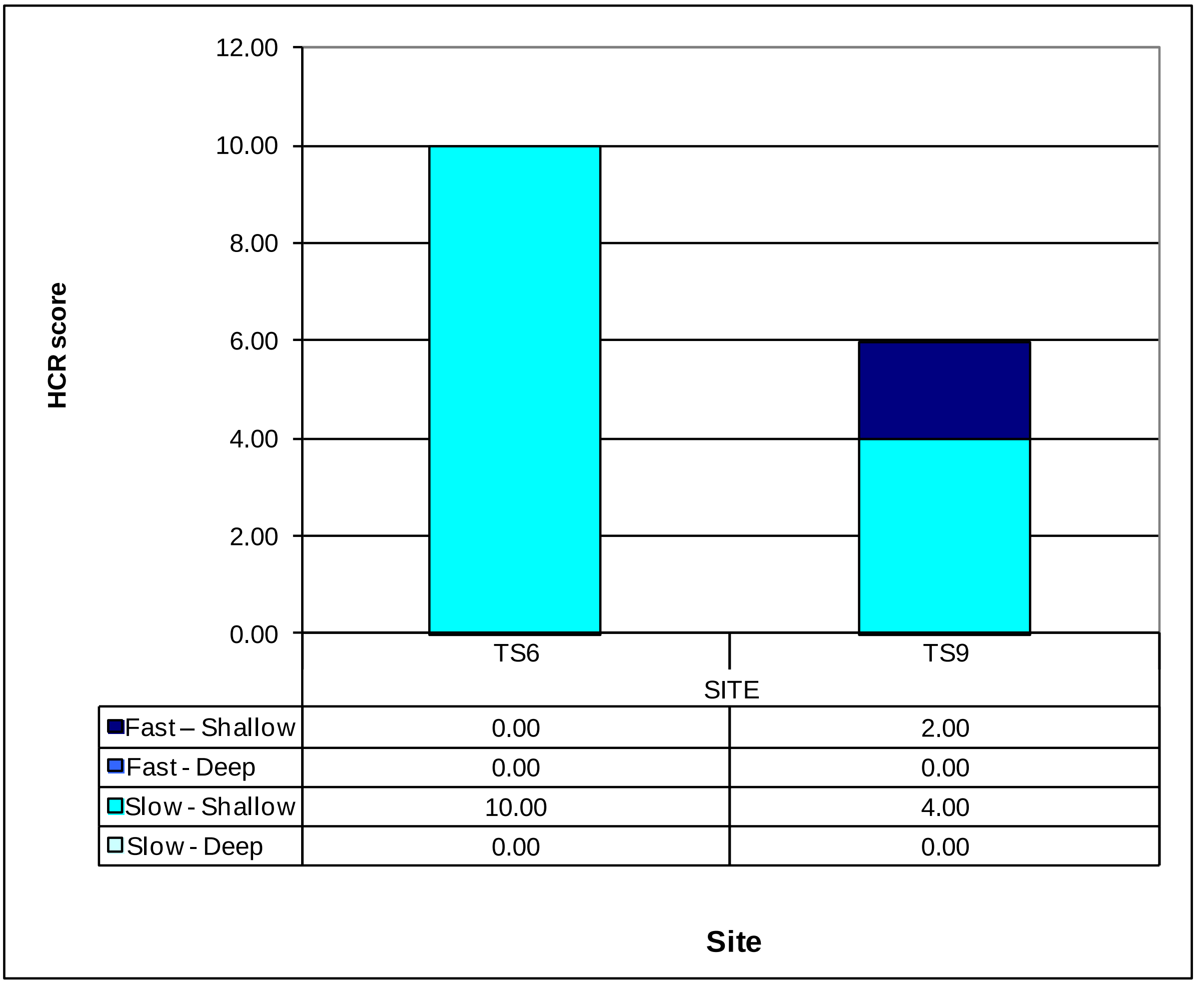


Figure 59: HCR scores for Tsitsa River tributary sites TS6 and TS9.

Assessment and sampling resulted in no fish being collected at any of the tributary sites. Because of the depauperate fish species diversity in the area, fish are not expected to occur in the small and shallow sites TS2, TS3 and TS5. However, as fish are expected to occur at sites TS6 and TS9 only HCR ratings for these two sites were provided in **Table 35**. Site TS6 presented with slow flow conditions only, whilst the latter was combined with some fast flow in riffle areas at siteTS9.

5.3.9 Fish Biota: Fish Response Assessment Index (FRAI)

The fish species expected to occur and frequency of occurrence (FROC) scores employed in the FRAI assessment were provided in **Table 5**. From this table it is clear that the fish fauna in the quaternary catchment is depauperate with a naturally low diversity of fish species present.

No fish specimens were collected during sampling efforts but as previously indicated carp (*Cyprinus carpio*) was observed in the Tsitsa River. It can be assumed that this fish species will also occur in the Tsitsa River tributaries where conditions permit. This fish species is thus likely to occur at sites TS6 and TS9.
Furthermore, although not collected, the longfin eel (*Anguilla mossambica*) is also likely to be present at these two sites (**Table 38**).

Table 38: Fish species observed during collections or known to occur at the various sites on the Tsitsa River.

SPECIES NAME	Number of fish collected at sites TS1, TS4, TS7 and TS8	Frequency of occurrence score (FROC)
Cyprinus carpio	Known to occur in system and sites conducive to them being present	1
Anguilla mossambica		1

The table below (**Table 39**) summarises the EC obtained using the FRAI. For ease of comparison the EC values obtained by using the MIRAI have again been included.

Table 39: Summary of the results (ecological categories) obtained from the application of the FRAI to the TS6 (Inxu River) and TS9 (unnamed tributary of the Tsitsa River) assessment sites, compared to that obtained using MIRAI as well as that obtained for the Tsitsa River.

River assessed	Inxu River (TS6), unnamed tributary of the Tsitsa River (TS9) and Tsitsa River (TS1, TS4, TS7 and TS8)		
Variable / Index	**TS6**	**TS9**	**TS1, TS4, TS7 and TS8**
Automated FRAI (%)	30.5	30.2	30.5
Automated EC (FRAI)	E	E	E
Refined EC (FRAI)	D/E*	D/E*	D/E*
Ecological category (EC) (MIRAI)	Borderline D and E/F	E/F	C/D

EC = Ecological category; * = No species expected/collected during assessments and habitat not conducive to known species being present based on sampling at the other sites.

The EC calculated for the FRAI corresponds to that obtained for the MIRAI for the Inxu River and to a lesser extend the Tsitsa River unnamed tributary and Tsitsa River sites. However, the naturally depauperate fish diversity in the quaternary catchment combined with the fact that no fish were collected during the sampling effort in April 2014, confounds any direct comparisons in terms of the effects of common/shared ecological drivers that may affect both the MIRAI and FRAI indices.

Based on the findings of the fish community assessments of the Tsitsa River tributaries, the proposed project is deemed likely to have a very limited impact on the fish ecology of the region.

5.4 SYNOPTIC OVERVIEW OF CURRENT AQUATIC ECOLOGICAL CONDITIONS AND POTENTIAL IMPACTS

To facilitate detailed assessment of potential impacts and suggest mitigation measures, the quaternary catchment ecological importance of the development areas and outcome of the aquatic assessment is summarised in **Tables 40** and **41** respectively, followed by an overview discussion on potential impacts anticipated.

Table 40: Summary of site relevance to proposed developments and quaternary catchment ecological states

Development	Relevant sites	EIS	PES	DEMC
Ntabelanga Dam development	TS1 and TS4	High	C	B
Roads associated with Ntabelanga Dam construction	TS2, TS3 and TS5	Moderate to high	C	C/B
Area between Ntabelanga Dam and Lalini Dam	TS6	Moderate to high	C	C/B
Lalini Dam development	TS7 and TS8	Moderate	C	C
Pipeline development	TS9	Moderate to high	C	C/B
EIS = Ecological importance and sensitivity; PES = Present ecological state; DEMC = Desired ecological management class.				

The greater study area can thus be said to be of moderate to high ecological importance.

Table 41: Summary of the results (ecological categories) obtained from the application of the various indices to the Tsitsa River and tributaries

Assessment	Month	Sites								
		Tsitsa River				Inxu River (TS6) and other unnamed tributaries of the Tsitsa River				
		TS1	TS4	TS7	TS8	TS2	TS3	TS5	TS6	TS9
IHIA	April 2014*	B	B	C	C	C	B	C	C	C
IHAS	April 2014	Highly suited	Ade-quite.	Ade-quite.	Ade-quite.	Ade-quite.	Inade-quite.	Inade-quite.	Ade-quite.	Ade-quite.
	June 2014	Ade-quite.	Ade-quite.	Ade-quite.	Highly suited	Ade-quite.	Inade-quite.	Inade-quite.	Ade-quite.	Ade-quite.
Dickens and Graham (SASS5)	April 2014	C	C	C	C	D	C	D	C	D
	June 2014	C	C	D/E	C	D	C	E	D	E
Dallas (SASS5)	April 2014	A	C	A	A	D/E/F	E/F	D	E/F	D/E/F
	June 2014	B	C	D	B	B	D/E/F	E/F	D/E/F	E/F
MIRAI	April 2014	B	C	B	C	D	C	D	C	D
	June 2014	C	C	C	C	C	C	D	C	D
FRAI	April 2014*	D	D	D	D	**	**	**	E	E

Abbreviations and footnotes:
IHIA = Invertebrate habitat integrity assessment; IHAS = Invertebrate habitat assessment; SASS5 = South African scoring system; MIRAI = Macro-invertebrate response assessment index; FRAI = Fish response assessment index; NA = Not assessed.
*April 2014 conditions also representative of June 2014 conditions with reference to IHIA and FRAI;
** Conditions not suitable for habitation by fishes.

The ecological importance of the greater study area is reflected in the aquatic assessment results obtained, particularly with reference to the four sites on the larger Tsitsa River (classifications ranging between A to C for assessments pertaining to invertebrates and invertebrate habitat). Fish fauna diversity was, however, depauperate as was also indicated in literature sources consulted. Smaller streams are thought to be less resilient to environmental change and more sensitive to disturbances, simply because of the smaller spatial scale in terms of potential areas of refugia and associated faunal and floral diversity to act as “buffer” to change. This is also reflected in the assessment results, with the tributary assessments generally yielding lower classifications. Seasonal changes in terms of the macro-invertebrate assessments are evident, with lower classifications being recorded during the lower flow period in June 2014. However, the contributions of lower flow and hence also potentially poorer water quality, as well as potential diffuse and point sources (agriculture activities and existing rural settlements) cannot be quantified at present.

Table 42: Summary of site relevance to proposed projects and general potential impacts associated with such development

Development	Relevant sites	General potential impacts
Ntabelanga Dam development	TS1 and TS4	Both sites are located on the larger Tsitsa River. During the construction phase restriction of flow, further destruction of bank cover and release of silt/sediment particles possibly resulting in discoloration and inundation is considered to be the most important potential impacts. After construction disruption of flow, also in terms of seasonal flow patterns, is considered the most significant impact along with the extensive loss of natural riverine habitat due to the inundation of the valley and the associated loss of aquatic community structure sensitivity and function. This impact is particularly pertinent as the system is reliant on clear fast flowing water to support the aquatic macro-invertebrate community of the area (as deduced from the MIRAI habitat preference tables discussed previously). Impacts on the Tsitsa River may thus impact the system on a much larger scale. Given the depauperate fish species diversity, potential impact on macro-invertebrates communities are expected to be far more significant throughout the system than on the fish community. However, the still deep impoundments created are likely to lead to a very significant increase in the population of the alien fish species *Cyprinus carpio* and increased impacts on the migratory connectivity of eels.
Roads associated with Ntabelanga Dam construction	TS2, TS3 and TS5	Anticipated impacts resulting from construction and use of roads include vegetation removal, increased risk of erosion, sediment loading into the system and inhibition of water flow. if not designed correctly roads can severely impact on instream habitat as well as bankside stability and riparian habitat
Area between Ntabelanga Dam and Lalini Dam	TS6	The Inxu River is the largest tributary and may also potentially act as “refugia” from where smaller tributaries can be populated. However, with limited diversity of flow and habitat types (very little rocky habitat) the potential to do so is also limited. Potential impacts may be the same as for the Tsitsa River sites, but being a tributary impacts resulting from changed flow rates may be less severe.
Lalini Dam development	TS7 and TS8	As for sites TS1 and TS4 and the Ntabelanga dam site
Pipeline development	TS9	Impact resulting from construction and use of roads as well as extensive digging are considered the greatest risk. Impacts as for TS2, TS3 and TS5.

The potential impacts will be discussed in terms of specific phases in the sections that follow.

6. IMPACT ASSESSMENT SCOPE AND GENERAL MITIGATION

6.1 SCOPE OF IMPACT ASESSMENT

This Chapter presents the findings of the environmental impact assessment for the dams and associated activities (DEA Ref no. 14/12/16/3/3/2/677).

The activities assessed under this chapter are listed below:

- The Ntabelanga and Lalini Dams;
- Five flow gauging weirs;
- Primary and secondary bulk potable water infrastructure:
  - Primary infrastructure: main water treatment works, including four major treated water pumping stations and three minor treated water pumping stations, main bulk treated water rising mains, and eight Command Reservoirs that will supply the whole region;
  - Secondary distribution lines: conveying bulk treated water from Command Reservoirs to existing and new District Reservoirs;
- Bulk raw water conveyance infrastructure (abstraction, pipelines, one raw water pumping station, one reservoir and two booster pumps) for irrigated agriculture (raw water supply up to field edge);
- Impact of commercial agriculture in earmarked irrigation areas;
- WWTWs at the Ntabelanga and Lalini Dam sites;
- Accommodation for operational staff at the Ntabelanga and Lalini Dam sites;
- Ten construction materials quarries and borrow pits;
- River intake structures and associated works;
- Information centres at the two dam sites; and
- Miscellaneous construction camps, lay down areas, and storage sites.

6.2 GENERAL MANAGEMENT AND GOOD HOUSEKEEPING PRACTICES

Latent and general everyday impacts which may impact on the aquatic ecosystem will include any activities which take place within the Lalini and Ntabalanga study areas that may impact on the receiving environment. These impacts are highlighted below and are relevant for all sensitive aquatic related areas identified in this report.

- No areas falling outside of the study area may be cleared for construction purposes;
- Ensure that operational related activities are kept strictly within the development footprint;
- Do not allow dumping of refuse within the surrounding environment;
- The boundaries of the development footprint areas are to be clearly defined and it should be ensured that all activities remain within defined footprint areas;
- The proposed development footprint areas should remain as small as possible;
- Edge effects of all construction activities, such as erosion and riparian zone alien plant species proliferation, which may affect aquatic habitat within surrounding areas, need to be strictly managed in all areas of increased ecological sensitivity;
- In the event of a breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced to prevent the ingress of hydrocarbons into the topsoil, as this may end up in the aquatic systems due to run-off;
- Vehicles should be restricted to travelling only on designated roadways to limit the ecological footprint of the proposed development activities;
- No trapping or hunting of fauna is to take place;
- All informal fires in the vicinity of construction areas should be prohibited to prevent impacts on the riparian vegetation and stream substrate;
- Throughout the life of the operation and prior to construction aquatic biomonitoring should take place to develop a set of baseline data and monitor aquatic ecological trends in the receiving environment at strategic points upstream and downstream of the impoundments, weirs and crossings;
- The WWTW must be well managed and strict monitoring and control of effluent discharge must take place to ensure that the impact on the receiving environment is minimised;
- Aquaculture would be a viable option in the impoundments. This is especially true since the segment of the river is not sensitive from a fish ecology point of view. The Ntabelanga Dam may be suitable for aquaculture with trout as the water in the dam may be cool enough to support the fish at this point in the system. Both the Ntabelanga dam and the Lalini dam can potentially be used for aquaculture of Tilapia (*Oreochromis mossamicus*) and/or catfish (*Clarias gariepinus*). Tilapia have more commercial value but both can definitely contribute to the production of protein in the area. which is generally lacking in protein production.

7. IMPACT ASSESSMENT FOR DAMS AND ASSOCIATED WATER INFRASTRUCTURE

This Chapter presents the findings of the environmental impact assessment for the dams and associated activities (DEA Ref no. 14/12/16/3/3/2/677).

The activities assessed under this chapter are listed below:

- The Ntabelanga and Lalini Dams;
- Five flow gauging weirs;
- Primary and secondary bulk potable water infrastructure:
  - Primary infrastructure: main water treatment works, including four major treated water pumping stations and three minor treated water pumping stations, main bulk treated water rising mains, and eight Command Reservoirs that will supply the whole region;
  - Secondary distribution lines: conveying bulk treated water from Command Reservoirs to existing and new District Reservoirs;
- Bulk raw water conveyance infrastructure (abstraction, pipelines, one raw water pumping station, one reservoir and two booster pumps) for irrigated agriculture (raw water supply up to field edge);
- Impact of commercial agriculture in earmarked irrigation areas;
- WWTWs at the Ntabelanga and Lalini Dam sites;
- Accommodation for operational staff at the Ntabelanga and Lalini Dam sites;
- Ten construction materials quarries and borrow pits;
- River intake structures and associated works;
- Information centres at the two dam sites; and
- Miscellaneous construction camps, lay down areas, and storage sites.

7.1 CONSTRUCTION AND FIRST FILL PHASES

7.1.1 Loss of aquatic habitat

Habitat destruction is the alteration of a natural habitat to the point that it is rendered unfit to support the species dependent upon it as their home territory. Many organisms previously using the area are displaced or destroyed, reducing biodiversity. Globally modification of habitats for agriculture is the chief cause of such habitat loss. Other causes of habitat destruction include surface mining, deforestation, slash and burn practices and urban development. Habitat destruction is presently ranked as the most significant cause of species extinction worldwide. Additional causes of habitat destruction include water pollution, introduction of alien species, overgrazing and overfishing. Riverine systems and particularly larger riverine systems or river systems that have sites suitable for impoundment are particularly susceptible to changes in habitat condition due to the need to impound drainage systems to supply water to communities, agriculture and industry.

The proposed dam construction project has significant potential to lead to habitat loss and/or alteration of the aquatic and riparian resources on the study area. Dam wall construction activities itself will be disruptive to current habitat conditions in the Tsitsa River within the dam wall footprint area and associated adjacent laydown areas. Construction activities also generally result in destruction of bank cover, generation of loose soil and other debris that may result in silting and sedimentation of downstream habitat. Apart from dam wall construction, construction of flow gauging weirs, bulk potable water infrastructure (pumping stations, reservoirs, treatment works and distribution lines) and bulk raw water conveyance infrastructure (pipelines, pumping station and reservoir) quarries and borrow pits, accommodation infrastructure and infrastructure will potentially have the same effect on the aquatic resources of the region albeit on a much smaller local scale. The macro-invertebrates community of the Tsitsa River relies on clear water and a stream substrate that is clear of fine silt and sediment. Close monitoring of erosion patterns downstream of the construction area is deemed essential and any areas which are showing erosion to be occurring should immediately be rehabilitated through resloping, stabilisation and revegetation techniques as part of the catchment management plan.

In addition inundation of upstream habitat as the dam fills will result in severe habitat changes, pertaining to the water column depth habitat as well as availability of riffle and rapid habitats upstream of the dam on a local scale. The impounding of the dam will thus lead to a significant loss of habitats comprising of flowing water over rock substrate which is significant for many aquatic macro-invertebrate taxa in the system. In addition less desirable species of fish such as *Micropterus salmoides* and *Cyprinus carpio* will become dominant in the system to the detriment of the endemic ecology of the region. Impacts due to sedimentation can be significant and have the potential to affect the biodiversity and functioning of the system. The still water in the newly created impoundment will allow sediment to settle and will smother the rocky substrate in the stream leading to a loss of rocky habitat types.

Loss of aquatic habitat	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Proposed Project with Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local (2)	Permanent – no mitigation (5)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – no mitigation (5)	High (4)	High (5)	Definite (5)	High	High
Lalini Dam size 1 (preferred) and associated infrastructure							
Without Mitigation	Local (2)	Permanent – no mitigation (5)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – no mitigation (5)	High (4)	High (5)	Definite (5)	High	High
Lalini Dam size 2 (alternative) and associated infrastructure							
Without Mitigation	Local (2)	Permanent –	High (4)	High (5)	Definite (5)	High	High

Loss of aquatic habitat	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
		no mitigation (5)					
With Mitigation	Site (1)	Permanent – no mitigation (5)	High (4)	High (5)	Definite (5)	High	High
Lalini Dam size 3 (alternative) and associated infrastructure							
Without Mitigation	Local (2)	Permanent – no mitigation (5)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Site (1)	Permanent – no mitigation (5)	High (4)	High (5)	Definite (5)	High	High
Please note that reference to the respective projects also considers impact from associated activities, including gauging weirs, bulk potable water infrastructure, bulk raw water conveyance infrastructure, irrigation and agriculture, WWTWs, accommodation infrastructure, quarries and pits, river intake structures and associated works, information centres and miscellaneous activities like constructions camps, lay down areas and storage sites.							
Cumulative Impact – Construction of the dam wall may result in destruction of bank cover and site-specific habitat types. First filling will result in inundation resulting in a variety of habitat types over a large area being permanently lost. The larger the dam the greater the area affected by inundation, shifting impact from site specific to local relevance with specific mention of the management of instream flows.							

Recommended mitigation

- The construction of the dams will lead to reduced stream flow and hence loss of fast shallow riffle habitat and glide habitat. This impact is considered to be of high significance in the construction phase and even with mitigation the impact remains relatively unchanged. It is however deemed important that during construction the maintenance of base flows in the system is maintained at all times and that the duration of impacts on flows is limited to as short a period as possible.
- Ensure that all stockpiles are well managed and have measures such as berms and hessian sheets implemented to prevent erosion and sedimentation;
- Through ensuring that good construction practice is followed in terms of the clearing of areas, such as the use of water control berms and clearing footprint areas that are as small as possible, the severity of the impact can be reduced;
- Ongoing aquatic biomonitoring on a minimum of a quarterly basis must take place from six (6) months prior to construction till one (1) year after construction to determine trends in ecology and define any impacts requiring mitigation.

7.1.2 Impact on flow dependant species

The damming of drainage areas that occur upstream of the proposed dam walls will lead to a loss of flow and an altered instream flow regime in the Tsitsa River system further downstream. It is notable that the aquatic macro-invertebrate community of the Tsitsa River system are reliant on good flow of water over the rocky stream substrate and the area downstream of the Lalini Dam, due to the remote nature of the gorge has an intact biodiversity. Impacts on instream flow can be significant and has the potential to affect the biodiversity and functioning of the system. Apart from the dam wall itself resulting in local to regional impact, gauging weirs will also have a smaller, local impact in terms of flow, habitat alteration and risk of erosion and sedimentation. With the varying hydro-electric energy generation options, there are varying levels of impact significance on the receiving aquatic environment with the degree of impact varying based on the extent of river in which a significant portion of the instream flow will be lost. All the proposed options are considered to have a borderline high to very high level of impact prior to mitigation while with mitigation, with specific mention of adhering to the Environmental Water Requirement releases the overall significance of the impacts can be reduced to high level impacts.

Recommended mitigation

- It must be ensured that downstream of both the Ntabelanga dam as well as Lalini Dam that the flows as defined in the EWR are maintained at all times to support the flow sensitive aquatic macro-invertebrate community in this system;
- Impact on flow-dependent species is considered to be of high to very high importance in the construction phase and even with mitigation the impact remains relatively unchanged;
- During construction the maintenance of base flows in the system must be maintained at all times and the duration of impacts on flows should be limited to as short a period as possible.

Impact on flow dependant species	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Proposed Project with Ntabelanga Dam and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
Proposed Project with Lalini Dam size 1 (preferred) and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
Proposed Project with Lalini Dam size 2 (alternative) and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with	High (4)	High (5)	Definite (5)	High	High

		mitigation (4)					
Proposed Project with Lalini Dam size 3 (alternative) and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
Please note that reference to the respective projects also considers impact from associated activities, including gauging weirs, bulk potable water infrastructure, bulk raw water conveyance infrastructure, irrigation and agriculture, WWTWs, accommodation infrastructure, quarries and pits, river intake structures and associated works, information centres and miscellaneous activities like constructions camps, lay down areas and storage sites.							
Cumulative Impact – Construction of the dam wall will restrict downstream flow to baseline as required by legislation. This will result in reduced downstream flow, particularly in terms of seasonal flow variation, that will affect flow-sensitive macro-invertebrate community composition and also possibly eel migration negatively. Upstream of the development inundation will also reduce flow and negatively affect flow-sensitive species.							

7.1.3 Loss of aquatic biodiversity

The Tsitsa River is regarded as being of very high importance for migration of eels although the significance of eel migration is considered limited. The system may also provide some migratory connectivity for smaller faunal species including avifauna. In addition to impacts on migration impacts on habitat and instream flow are likely to lead to impacts on biodiversity with the loss of taxa which are sensitive to habitat changes as well changes/reductions in flow.

In particular, the impact on the aquatic macro-invertebrate community which relies on rocky substrate in fast flowing clear water will be significantly impacted by the proposed development.

Loss of aquatic biodiversity	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Proposed Project with Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	High (5)	Definite (5)	High	High
Proposed Project with Lalini Dam size 1 (preferred) and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – with mitigation (4)	Medium (3)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	High (5)	Definite (5)	High	High
Proposed Project with Lalini Dam size 2 (alternative) and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with	Medium (3)	High (5)	Definite (5)	High	High

		mitigation (4)					
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	High (5)	Definite (5)	High	High
Proposed Project with Lalini Dam size 3 (alterative) and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	High (5)	Definite (5)	High	High
Please note that reference to the respective projects also considers impact from associated activities, including gauging weirs, bulk potable water infrastructure, bulk raw water conveyance infrastructure, irrigation and agriculture, WWTWs, accommodation infrastructure, quarries and pits, river intake structures and associated works, information centres and miscellaneous activities like constructions camps, lay down areas and storage sites.							
Cumulative Impact – Construction of the dam wall will negatively affect biodiversity in the immediate site vicinity because of direct impacts resulting from habitat destruction and flow disruption. Inundation upstream will result in further habitat destruction and with associated downstream base flow restriction, impact extent will be local.							

The movement of instream taxa, with special mention of eels, will be severely affected by the proposed dam, including local effects from gauging weirs. Impacts on migratory movements are likely to occur during the construction and operational phase of the proposed development. In the long term this may negatively affect populations upstream of the dams and may result in loss of this species in certain sections.

In addition loss of habitat and alteration of flow rate discussed previously will also negatively affect the diversity of the macro-invertebrate community within the system on a local scale. Even with mitigation the impact on aquatic ecology is considered high.

Recommended mitigation

- Even with attempted mitigation, impact will remain high;
- During construction the maintenance of base flows in the system must be maintained at all times and the duration of impacts on flows should be limited to as short a period as possible;
- Ongoing aquatic biomonitoring on a minimum of a quarterly basis must take place from six (6) months prior to construction till one (1) year after construction to determine trends in ecology and define any impacts requiring mitigation.

7.1.4 Impact on species with conservation concern

The proposed infrastructures, with special mention of the proposed dam and to a lesser extent gauging weirs, will lead to the formation of an migratory barrier for fish species and in particular eels, as mentioned in the previous section. The area is known to harbour endemic mayflies (Kleynhans 1999). With the location of the two dams situated between two waterfalls and hence geographically isolated, the area is likely to contain several macro-invertebrate species of conservation concern. Both prior to and after mitigation this impact is considered to be high to moderately high. Through minimising the time in which stream flow, water quality and habitat is affected during the construction phase of the project this impact can, however, be mitigated to a limited degree. The "construction phase" does not only refer to dam wall construction, but also all related activities and in particular the gauging weirs.

Recommended mitigation

- Even with attempted mitigation impact will remain high, as first filling causing upstream inundation and alteration of flow rate downstream cannot be mitigated to any great extent.
- During construction the maintenance of base flows in the system must be maintained at all times and the duration of impacts on flows should be limited to as short a period as possible.

Loss of aquatic biodiversity	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Proposed Project with Ntabelanga Dam and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	High (5)	High(4)	High	Medium-High
Proposed Project with Lalini Dam size 1 (preferred) and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – no mitigation (5)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	High (5)	High(4)	High	Medium-High
Proposed Project with Lalini Dam size 2 (alternative) and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – no mitigation (5)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	High (5)	High(4)	High	Medium-High
Proposed Project with Lalini Dam size 3 (alternative) and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – no mitigation (5)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	High (5)	High(4)	High	Medium-High
Please note that reference to the respective projects also considers impact from associated activities, including gauging weirs, bulk potable water infrastructure, bulk raw water conveyance infrastructure, irrigation and agriculture, WWTWs, accommodation infrastructure, quarries							

Loss of aquatic biodiversity	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
and pits, river intake structures and associated works, information centres and miscellaneous activities like constructions camps, lay down areas and storage sites.							
Cumulative Impact – Two taxa of concern are local mayflies species (Order Ephemeroptera) and to a lesser extend eels. Construction of the dam wall will have limited direct negative effects but changes resulting from initial filling will result in more substantial negative effects. This will pertain to destruction of habitat limiting habitat suitable to mayfly inhabitation as well as creating barriers to eel migration.							

7.2 OPERATION PHASE

In terms of aquatic ecology impact, the three different size options for the proposed Lalini Dam will only have geographical relevance on a site to local scale. In other words, the larger the dam the more likely impact will move towards local as opposed to site relevance, especially with reference to construction and first fill events.

However, during operation the impact will remain local for all dam size alternatives. Dam size differences will also have no effect on the duration or intensity impacts associated with the operation.

However, flow regime to be employed during the operation phase of both Lalini and Ntabelanga Dams will have greater relevance in terms of impact. As a result, for the purpose of discussing operation phase impact, dam size options in tables to follow have been replaced with the following three flow regime options: base generation only and peak generation. Base generation is assumed to be based on regulating generation and flow in the tunnel to meet the EWR. The latter is the preferred alternative. As with assessment of the first filling and construction phase, all activities related to the respective dam projects were considered in both the discussions and the tabulated impacts assessments that follow.

Under peak hourly operation there are up to six peak hours per day split between the morning and evening peak consumption periods, namely breakfast and evening meal times. Peaking months would be May to October inclusive, when the plant is being run on a semi-peaking mode with an installed capacity of 37.5 MW or 50 MW. Due to the perceived highly significant impact, due to flow variations induced in the system, peak generation is not considered appropriate to this project.

7.2.1 Loss of aquatic habitat

Loss of upstream riverine aquatic habitat resulting from inundation during filling will be permanent. Disruption of habitat downstream from the proposed Dam site will vary largely depending on flow rates. The most significant impact on habitat will be within the impoundments where permanent loss of all riverine habitat below the full supply level will occur permanently. The impact on the areas downstream of the impoundments will be less affected with the degree of impact determined by the degree to which the instream flow requirements downstream of the dams are met as well as the way in which hydroelectric energy generation takes place and in particular base and peak energy generation options.

The section directly below the dam wall up to the dam discharge point will only experience controlled base flow conditions at most times that would lead to impairment of the waterfall habitat as well as loss of seasonal natural flow fluctuation events that will affect availability of especially riffle and rapid habitats. Base generation flow only will affect the section after the discharge point by potentially leading to reduced instream flows but more likely elevated instream flows in relation to the natural discharge which would occur under natural conditions. This is particularly evident in the winter months when the release from the hydro tunnel will be higher than natural flows in the winter months. Peak flow will result in daily changes in habitat availability. Ill managed base and peak generation are considered likely to impact on the system highly. Well managed base generation based on available water and based on the simulation of natural stream discharge patterns, as defined by the EWR is considered the most suitable option for the proposed development.

Loss of aquatic habitat	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Proposed Project with Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-high
Proposed Project with Lalini Dam Base generation only and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-high
Proposed Project with Lalini Dam Peak time generation and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-high
Proposed Project with Lalini Dam Variable base generation and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with	Medium (3)	Medium (3)	High (4)	High	Medium-high

		mitigation (4)					
Please note that reference to the respective projects also considers impact from associated activities, including gauging weirs, WWTWs, accommodation infrastructure, river intake structures and associated works and information centres.							
Cumulative Impact and Comments – Base generation will preclude natural seasonal variation in flow to some degree, which may include scouring of the system to maintain riffle and rapid habitats and alter breeding ques. Absence of such events will lead to long-term loss of certain habitat types and the associated aquatic biota. Peak flow will result in daily variations in habitat availability. Seasonal peak flow will restrict such variations to one season (winter) only. Mitigation measures with reference to individual peak flow regimes are not possible, with mitigation effect value of each option to be evaluated individually as part of the EWR assessment.							

Recommended mitigation

- Loss of habitat will impact on a regional scale with the duration permanent however impacts downstream of the impoundments can be mitigated through management of the flow regime to simulate natural discharge patterns throughout the year. The intensity of impact is considered high, with loss of resources and a definite probability of occurrence in all instances. Maintenance of base flow is to be maintained and energy generation should take place by means of Well managed base generation based on available water and based on the simulation of natural stream discharge patterns, as defined by the EWR.

7.2.2 Impact on flow dependant species

Abstraction for agricultural and other purposes from Ntabelanga Dam, will negatively affect the amount of water for release and hence flow in the river section between the Ntabelanga and Tsitsa Dams. Even with the base- and peak flow regimes in operation at Lalini Dam, the river section between the dam wall and entry point of the discharge pipe will experience controlled base flows at most times which may affect some more sensitive taxa. As discussed in the section above there will be an impact on the aquatic community downstream of the dam due to the impacts altered streamflow regimes.

Impact on flow dependant species	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Proposed Project with Ntabelanga Dam and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – with mitigation (4)	High (4)	Medium (3)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
Proposed Project with Lalini Dam Base flow only and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – with mitigation (4)	High (4)	Medium (3)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
Proposed Project with Lalini Dam Peak time generation and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – with mitigation (4)	High (4)	Medium (3)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
Proposed Project with Lalini Dam Variable base generation and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – with mitigation (4)	High (4)	Medium (3)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
Please note that reference to the respective projects also considers impact from associated activities, including gauging weirs, WWTWs, accommodation infrastructure, river intake structures and associated works and information centres.							
Cumulative Impact and Comments – Base energy generation only will alter natural variation in flow. Peak energy generation is not considered appropriate for this system. The Lalini Dam section below the dam wall up to where the discharge pipe enters will experience							

constant significantly altered flow regimes. This will result in permanent changes in flow in this river segment as well seasonal variation in flow. Upstream, flow will be permanently disrupted due to inundation. It is essential that the Ntabalanga and Lalini dams be managed conjunctively to ensure that EWR's are met and natural discharge patterns are accurately simulated.

With an altered flow regime the river system, this section may be subjected to excessive vegetation growth or silting over the long term which will negatively affect flow-dependant species. Daily peak energy generation will lead to drastic daily fluctuations in flow rate that will also negatively affect flow-sensitive species and a change in the natural aquatic macro-invertebrate community structure is deemed highly likely. For this reason peak generation is not deemed appropriate. If base generation is employed base generation where flows through the entire system are not well managed will impact on natural discharge patterns through the year leading to constant high flows which will impact significantly on the system and is not deemed appropriate. Well managed base generation based on available water and based on the simulation of natural stream discharge patterns, as defined by the EWR is considered to have a significantly lower impact.

Recommended mitigation:

- The impact on the aquatic community structures within the full supply level will be very significant with drastic changes to the aquatic community structure in these areas with more sensitive taxa no longer occurring and less desirable species of fish becoming dominant in the system;
- The impact on stream flow during the operational phase of the project is high if no mitigatory measures are implemented;
- If mitigation takes place through ensuring that some release of water takes place throughout the life of the operation to recharge the downstream riverine and wetland resources and to ensure that base flows are maintained at all times, the severity of the impact can be reduced. However, the impact is still regarded as being a medium-high level impact.
- Well managed base generation based on available water and based on the simulation of natural stream discharge patterns, as defined by the EWR is deemed the most appropriate regime for the system.

7.2.3 Loss of aquatic biodiversity

The proposed dam walls will lead to the formation of migratory barrier and the movement of instream taxa, with special mention of eels, will be severely and permanently affected. No mitigation for eel migration is possible. As for the construction phase, permanent alteration of natural flow rates and habitat will negative affect aquatic biodiversity with specific reference to macro-invertebrates and riparian vegetation.

Loss of aquatic biodiversity	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Proposed Project with Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
Proposed Project with Lalini Dam Base generation only and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
Proposed Project with Lalini Dam Peak time generation and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
Proposed Project with Lalini Dam Base generation in summer and Peak generation in winter and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with no mitigation (5)	Medium (3)	Medium (3)	High (4)	High	Medium-High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
Please note that reference to the respective projects also considers impact from associated activities, including gauging weirs, WWTWs, accommodation infrastructure, river intake structures and associated works and information centres.							
Cumulative Impact and Comments – Both changes in habitat modification as well as flow regime will be permanent. Mitigation measures, either in terms of base flow or variation in flow when employing a peak generation, will result in constant impact that would preclude species sensitive to either habitat or flow suitability. Decrease in biodiversity is deemed unavoidable.							

Recommended mitigation:

- Even with attempted mitigation, impact will remain moderately high.
- The defined instream flow requirements must be adhered to at all times.
- Well managed base generation based on available water and based on the simulation of natural stream discharge patterns, as defined by the EWR is deemed the most appropriate regime for the system.

7.2.4 Impact on species with conservation concern

As described for the construction phase, impact pertains to eel migration and presence of endemic mayflies. With the two dams situated between two waterfalls and hence geographically isolated, the area is likely to contain several macro-invertebrate species of conservation concern. The impact associated with the operational phase will be permanent and the only mitigation measures applicable pertaining to flow regime.

Impact on species with conservation concern	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Proposed Project with Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	Medium (3)	High	Medium-Low
Proposed Project with Lalini Dam Base generation only and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	Medium (3)	High	Medium-Low
Proposed Project with Lalini Dam Peak time generation and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	Medium (3)	High	Medium-Low
Proposed Project with Lalini Dam Base generation in summer and Peak generation in winter and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
With Mitigation	Local (2)	Permanent – with	Medium (3)	Medium (3)	Medium (3)	High	Medium-Low

		mitigation (4)					
Please note that reference to the respective projects also considers impact from associated activities, including gauging weirs, WWTWs, accommodation infrastructure, river intake structures and associated works and information centres.							

Recommended mitigation:

- The instream flow requirements defined for the system must be maintained at all times.
- Well managed base generation based on available water and based on the simulation of natural stream discharge patterns, as defined by the EWR is deemed the most appropriate regime for the system.

8. IMPACT ASSESSMENT FOR ELECTRICITY GENERATION AND DISTRIBUTION INFRASTRUCTURE

This Chapter presents the findings of the environmental impact assessment for the electricity generation and distribution related activities (DEA Ref no. 14/12/16/3/3/2/678).

The activities assessed under this chapter are listed below:

- Pipeline and tunnel (including tunnel alternatives) at the proposed Lalini Dam leading to the Tsitsa River in the gorge downstream;
- Generation of hydro power and feeding of this power into the existing grid; and
- 18.5km power line from the Lalini Dam tunnel;
- In this section less focus was given instream impacts associated with instream flow and the releases from the hydro-electricity generation as these have already been dealt with as part of the discussions on the dam construction and will also be dealt with in detail as part of the Environmental Water Requirements studies and determinations.

8.1 CONSTRUCTION PHASE

8.1.1 Loss of aquatic habitat

Impacts due to canalisation and erosion will potentially be caused due to the disturbance of soils, during site clearing and construction, and the alteration of flow regimes in the Tsitsa River. Water released from the Lalini Dam during hydroelectric generation, if not correctly designed can also lead to erosion and canalisation of the system as well as changes to habitat downstream of the release point. This impact can be significant and has the potential to affect the hydrological functioning and biodiversity of riverine and wetland systems. However, if mitigated the impact can be restricted to construction sites and a short distance downstream and is considered low.

Recommended mitigation

- Limit the footprint area of the construction activity to what is absolutely essential in order to minimise the loss of clean water runoff areas and the concomitant recharge of streams in the area;
- Ensure that all stockpiles are well managed and have measures such as berms and hessian sheets implemented to prevent erosion and sedimentation;
- Through ensuring that good construction practice is followed in terms of the clearing of areas, such as the use of water control berms and clearing footprint areas that are as small as possible, the severity of the impact can be reduced.
- During construction the maintenance of base flows in the system must be maintained at all times and the duration of impacts on flows should be limited to as short a period as possible.

Loss of aquatic habitat	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance

Proposed Project with Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local (2)	Medium term (2)	Medium (3)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Low (3)	High (4)	High	Low
Proposed Project with Lalini Dam hydroelectric generation site 1 (near falls) and associated infrastructure							
Without Mitigation	Local (2)	Medium term (2)	Medium (3)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Low
Proposed Project with Lalini Dam hydroelectric generation site 2 (medium range) and associated infrastructure							
Without Mitigation	Local (2)	Medium term (2)	Medium (3)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Low
Proposed Project with Lalini Dam hydroelectric generation site 3 (furthest from falls largest generation potential) and associated infrastructure							
Without Mitigation	Local (2)	Medium term (2)	Medium (3)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Low
Please note that reference to the respective hydroelectric generation projects also considers impact from associated power lines and the Lalini Dam tunnel.							
Residual Impact and Comments– Construction of the development will have temporary impact that could be mitigated to some extent.							

8.1.2 Impact on flow dependant species

Impacts on flow will mostly pertain to general construction activities and baseline flow as effected through the Lalini Dam tunnel. These effects have been discussed with reference to dam impact. Construction of the electricity generation and distribution phases will have lower impact compared to that associated with the dams due to the smaller scale of both activity and potential impact.

Impact of flow dependant species	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Proposed Project with Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
Proposed Project with Lalini Dam hydroelectric generation site 1 (nearest to falls lowest generation potential) and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
Proposed Project with Lalini Dam hydroelectric generation site 2 (midway option) and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
Proposed Project with Lalini Dam hydroelectric generation site 3 (furthest from falls largest generation potential) and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
Please note that reference to the respective hydroelectric generation projects also considers impact from associated power lines and the Lalini Dam tunnel.							
Residual Impact and Comments– Construction of the development will have temporary impact that could be mitigated to some extent.							

Recommended mitigation

- Limit the footprint area of the construction activity to what is absolutely essential;
- During construction the maintenance of base flows in the system must be maintained at all times and the duration of impacts on flows should be limited to as short a period as possible.

8.1.3 Loss of aquatic biodiversity

Impacts on diversity will mostly pertain to habitat alteration and flow alteration as effected through the Lalini Dam tunnel. These effects have been discussed with reference to dam impact. Construction of the electricity generation and distribution phases will have lower impact compared to that associated with the dams due to the smaller scale of both activity and potential impact.

Loss of aquatic biodiversity	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Proposed Project with Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
Proposed Project with Lalini Dam hydroelectric generation site 1 (nearest to falls lowest generation potential) and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
Proposed Project with Lalini Dam hydroelectric generation site 2 (midway option) and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
Proposed Project with Lalini Dam hydroelectric generation site 3 (furthest from falls largest generation potential) and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
Please note that reference to the respective hydroelectric generation projects also considers impact from associated power lines and the Lalini Dam tunnel.							
Residual Impact and Comments– Construction of the development will have temporary impact that could be mitigated to some extent.							

Recommended mitigation

- Limit the footprint area of the construction activity to what is absolutely essential;
- During construction the maintenance of base flows in the system must be maintained at all times and the duration of impacts on flows should be limited to as short a period as possible; and
- Eelways should be incorporated into the design of the dam.

8.1.4 Impact on species with conservation concern

Impacts on species with conservation concern will mostly pertain to habitat alteration and flow alteration as effected through the Lalini Dam tunnel. These effects have been discussed with reference to the impacts associated with the proposed dams. Construction of the electricity generation and distribution phases will have lower impact compared to that associated with the dams due to the smaller scale of both activity and potential impact. It must however be noted that the further the tunnel daylights from the Lalini dam wall the larger the impact on the instream ecology will be.

Impact on species with conservation concern	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Proposed Project with Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Low (2)	High	Very low
Proposed Project with Lalini Dam hydroelectric generation site 1 (nearest to falls lowest generation potential) and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Low (2)	High	Very low
Proposed Project with Lalini Dam hydroelectric generation site 2 (midway option) and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Low (2)	High	Very low
Proposed Project with Lalini Dam hydroelectric generation site 3 (furthest from falls largest generation potential)							
High	Local (2)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Low (2)	High	Very low
Please note that reference to the respective hydroelectric generation projects also considers impact from associated power lines and the Lalini Dam tunnel.							
Residual Impact and Comments– Construction of the development will have temporary impact that could be mitigated to some extent.							

Recommended mitigation

- Limit the footprint area of the construction activity to what is absolutely essential;
- During construction the maintenance of base flows in the system must be maintained at all times and the duration of impacts on flows should be limited to as short a period as possible.

8.2 OPERATIONAL PHASE

8.2.1 Loss of aquatic habitat

Once construction is complete impact will be low. Water released from the Lalini Dam, if not correctly designed can lead to severe erosion and canalisation of the system at the point where the discharge from the Lalini Dam enters the river. This impact can be significant on a site to local scale in terms of river modification and habitat loss, with the potential to affect the hydrological functioning and biodiversity of riverine and wetland systems on a local to regional scale. The closer to the dam wall the pipeline enters the river, the shorter the section subjected to reduced instream flow will be. These impacts have been discussed previously with reference to the operational phase of the dams.

Loss of aquatic habitat	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Proposed Project with Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local (2)	Medium term (2)	Medium (3)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Low (1)	Low (2)	High	Very low
Proposed Project with Lalini Dam hydroelectric generation site 1 (nearest to falls lowest generation potential) and associated infrastructure							
Without Mitigation	Local (2)	Medium term (2)	Medium (3)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Low (1)	Low (2)	High	Very low
Proposed Project with Lalini Dam hydroelectric generation site 2 (midway option) and associated infrastructure							
Without Mitigation	Local (2)	Medium term (2)	Medium (3)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Low (1)	Low (2)	High	Very low
Proposed Project with Lalini Dam hydroelectric generation site 3 (furthest from falls largest generation potential) and associated infrastructure							
High	Local (2)	Medium term (2)	Medium (3)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Low (1)	Low (2)	High	Very low
Please note that reference to the respective hydroelectric generation projects also considers impact from associated power lines and the Lalini Dam tunnel.							

It must be noted that although the impact significance for each option of the Lalini dam was classified as being the same the further from the dam wall water is re-introduced to the system the larger the impact on the Tsitsa River due altered instream flows.

Recommended mitigation

- The discharge point and discharge structure must be designed and positioned in a way that would minimise incision, erosion and changes to instream habitat structures.
- The infrastructure should be adequately maintained to retain the smallest footprint possible and prevent post construction impacts on the local instream habitat due to a lack of infrastructure maintenance.

8.2.2 Impact on flow dependant species

Considering impact of dam operation on flow rate, contribution of run-off from hard services associated with the electricity generation and distribution phase development to flow rate alteration, is deemed negligible. Impact on flow dependent species will predominantly pertain to the discharge of water from the Lalini Dam pipeline into the river. Differences in flow regime have been discussed previously with reference to the proposed dam operation. It must be noted that although the impact significance for each option of the Lalini dam was classified as being the same the further from the dam wall water is re-introduced to the system the larger the impact on the Tsitsa River due altered instream flows.

Impact of flow dependant species	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Proposed Project with Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Low (1)	Low (2)	High	Very low
Proposed Project with Lalini Dam hydroelectric generation site 1 (nearest to falls lowest generation potential) and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Low (1)	Low (2)	High	Very low
Proposed Project with Lalini Dam hydroelectric generation site 2 (midway option) and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Low (1)	Low (2)	High	Very low
Proposed Project with Lalini Dam hydroelectric generation site 3 (furthest from falls largest generation potential) and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Low (1)	Low (2)	High	Very low
Please note that reference to the respective hydroelectric generation projects also considers impact from associated power lines and the Lalini Dam tunnel.							

Residual Impact and Comments– Construction of the development will have temporary impact that could be mitigated to some extent.

Recommended mitigation

- The Instream Flow Requirements defined for the Tsitsa system must be maintained at all times.
- The infrastructure should be adequately maintained to retain the smallest footprint possible and minimise post construction impacts on local habitat.

8.2.3 Loss of aquatic biodiversity

Potential loss of biodiversity, with particular reference to mayflies from the order *Ephemeroptera*, will mostly pertain to habitat alteration and flow alteration as effected through the Lalini Dam tunnel. These effects have been discussed with reference to dam impact. Construction of the electricity generation and distribution phases will have lower impact compared to that associated with the dams due to the smaller scale of both activity and potential impact. It must be noted that although the impact significance for each option of the Lalini dam was classified as being the same the further from the dam wall water is re-introduced to the system the larger the impact on the Tsitsa River due altered instream flows.

Impact of flow dependant species	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Proposed Project with Ntabelanga Dam and associated infrastructure							
Without Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Low (1)	Low (2)	High	Very low
Proposed Project with Lalini Dam hydroelectric generation site 1 (nearest to falls lowest generation potential) and associated infrastructure							
Without Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Low (1)	Low (2)	High	Very low
Proposed Project with Lalini Dam hydroelectric generation site 2 (midway option) and associated infrastructure							
Without Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Low (1)	Low (2)	High	Very low
Proposed Project with Lalini Dam hydroelectric generation site 3 (furthest from falls largest generation potential) and associated infrastructure							
Without Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Low (1)	Low (2)	High	Very low
Please note that reference to the respective hydroelectric generation projects also considers impact from associated power lines and the							

Lalini Dam tunnel.
Residual Impact and Comments– Construction of the development will have temporary impact that could be mitigated to some extent.

Recommended mitigation

- The Instream Flow Requirements defined for the Tsitsa system must be maintained at all times.
- The infrastructure should be adequately maintained to retain the smallest footprint possible and minimise post construction impacts on local habitat.

8.2.4 Impact on species with conservation concern

Impacts on species with conservation concern will mostly pertain to habitat alteration and flow alteration as effected through the Lalini Dam tunnel. These effects have been discussed along with the proposed dam construction impacts. Construction of the electricity generation and distribution phases will have lower impact compared to that associated with the dams due to the smaller scale of both activity and potential impact. It must be noted that although the impact significance for each option of the Lalini dam was classified as being the same the further from the dam wall water is re-introduced to the system the larger the impact on the Tsitsa River due altered instream flows.

Impact on species with conservation concern	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Proposed Project with Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Low (2)	High	Very low
Proposed Project with Lalini Dam hydroelectric generation site 1 (nearest to falls lowest generation potential) and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Low (2)	High	Very low
Proposed Project with Lalini Dam hydroelectric generation site 2 (midway option) and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Low (2)	High	Very low
Proposed Project with Lalini Dam hydroelectric generation site 3 (furthest from falls largest generation potential) and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Low (2)	High	Very low
Please note that reference to the respective hydroelectric generation projects also considers impact from associated power lines and the							

Lalini Dam tunnel.
Residual Impact and Comments– Construction of the development will have temporary impact that could be mitigated to some extent.

Recommended mitigation

- The Instream Flow Requirements defined for the Tsitsa system must be maintained at all times;
- Well managed base generation based on available water and based on the simulation of natural stream discharge patterns, as defined by the EWR is deemed the most appropriate regime for the system;
- The infrastructure should be adequately maintained to retain the smallest footprint possible and minimise post construction impacts on local habitat.

9. IMPACT ASSESSMENT FOR ROADS AND PIPELINE INFRASTRUCTURE

This Chapter presents the findings of the environmental impact assessment for the road infrastructure (DEA Ref no. 14/12/16/3/3/1/1169).

The activities included under this chapter are listed below:

- Upgrading and relocation of roads and bridges;
- Construction of new access roads around the Lalini Dam site.

9.1 CONSTRUCTION PHASE

During the construction phase initial impact will be local to establish the necessary infrastructure. Relocation and upgrading of bridges will have site specific impacts at riverine points of construction. Impacts due to canalisation and erosion will potentially be caused due to the disturbance of soils, during site clearing, and the alteration of flow regimes in the Tsitsa River and tributaries. If effectively mitigated, such impacts will be of short duration and low intensity. It must be noted that many of the crossings will be over small streams of limited ecological importance and sensitivity although due to the limited flow in the systems care must be taken during construction to not adversely affect these systems.

Probable latent impacts on a site specific to local scale thus include:

- Localised erosion (not significant);
- Localised changes to instream and riparian habitat (not significant);
- Localised sedimentation of the system may lead to altered instream habitat (potentially significant);
- Localised changes to instream and riparian habitat (not significant);
- Some localised changes to aquatic and riparian zone community assemblages (not significant).
- Some changes to the hydrology of the system may occur altering instream habitats on a localised scale (not significant).
- Localised changes to instream and riparian habitat and cover types (not significant);
- Some localised changes to aquatic and riparian zone community assemblages (not significant).

General impact	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Proposed Roadways							
Without Mitigation	Local (1)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Very low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Low (2)	High	Very low
Primary pipelines							

Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Very low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Low (2)	High	Very low
Secondary pipelines							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Very low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Low (2)	High	Very low
Irrigation pipelines							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Very low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Low (2)	High	Very low
Please note that reference to the respective projects also considers impact from upgrading of roads and bridges.							
Cumulative Impact and Comments– Construction of the development will have temporary impact that could be mitigated to some extent.							

Recommended mitigation

- All bridges should span the entire active channel (normal to moderately high flows) and no support piers should occur within the active channel;
- All crossing construction should be undertaken in the low flow season and must be completed within six (6) months;
- The duration of construction works needs to be kept to the absolute minimum and all project planning must be very well orchestrated to reach this goal;
- The construction infrastructure and coffer dams and stream diversions must at no time lead to upstream ponding and inundation or lead to the constriction of flow and downstream erosion;
- Minimise disturbance of instream and bankside areas and minimise activities in these areas;
- As far as possible keep all instream areas and stream banks off limits to general activity during the construction phase;
- Any construction-related waste must not be placed in the vicinity of any riparian areas;
- Ensure that on-site camp fires are forbidden;
- Edge effects (impacts on areas beyond the construction footprint due to less than desirable care and management) during construction and operation need to be strictly controlled through ensuring good housekeeping and strict management of activities near the stream crossing;
- During construction, drift fences constructed from hessian sheets should be installed at erodible areas to minimise erosion. Silt traps should also be provided to remove sand/silt particles from runoff;
- Limit the footprint area of the construction activity to what is absolutely essential in order to minimise environmental damage;
- Riparian areas that may have been disturbed during construction should be rehabilitated through reprofiling and revegetation upon completion of the construction phase;

- Desilt all riparian areas affected by construction activities;
- Reprofiling of the banks of disturbed drainage areas to a maximum gradient of 1 V : 3 H to ensure bank stability if necessary;
- Reinforce banks and drainage features where necessary with gabions, reno mattresses and geotextiles;
- During construction care must be taken to disrupt the riparian zone as little as possible to avoid erosion and sediment load into the system. This can be achieved by permitting only essential construction personnel within 32 m of all riparian systems; and
- Limit the footprint area of the construction activity to what is absolutely essential in order to minimise the loss of clean water runoff areas and the concomitant recharge of streams in the area.

9.2 OPERATION PHASE

Extensive development project activities often cause a change to peak flows in the river system downstream of the project site, due to changes in surface coverage. Development of a project area will change the surface coverage in some areas from vegetated soil to buildings, hardened gravel roads, paved areas (parking), and compacted earth. These new surface types will allow considerably less infiltration into the ground (typically 0-20%) as compared to the natural surface (typically 60-70%), resulting in more surface runoff following storms and consequently higher peak flow rates. However, considering inundation due to dam wall construction as well as base- and peak flow management during the operational phase, such an impact on river peak flow rates would be large insignificant on a local or regional scale. On a site specific scale run-off may result in erosion and sedimentation but such impact can be mitigated.

Recommended mitigation

- Roads and associated pipeline developments must be well maintained to avoid site specific impacts such as erosion or sedimentation resulting from run-off.
- Sheet runoff from access roads and the final road structure needs to be curtailed and slowed down by the strategic placement of energy dissipation structures;
- Adequate stormwater management must be incorporated into the design of the proposed structure in order to prevent erosion and the associated sedimentation of the system for the life of the structure; and
- As far as possible, all construction activities should occur in the low flow season, during the drier summer months;
- It must be ensured that migratory connectivity and stream continuity is maintained throughout the construction phase of the project;
- Removal of alien vegetation and good housekeeping within the road reserve must take place at all times;
- Any spills by maintenance teams or road users should be cleaned up immediately and all work overseen by a suitably qualified professional.

General impact	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Proposed road upgrades							
Without Mitigation	Local (1)	Short term (1)	Low (2)	Low (2)	Low (2)	High	Very low
With Mitigation	Site (1)	Short term (1)	Low (2)	Low (2)	Low (2)	High	Very low
Primary pipelines							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	Low (2)	High	Very low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Low (2)	High	Very low
Secondary pipelines							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	Low (2)	High	Very low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Low (2)	High	Very low
Irrigation pipelines							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	Low (2)	High	Very low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Low (2)	High	Very low
Please note that reference to the respective projects also considers impact from upgrading of roads and bridges.							
Cumulative Impact and Comments– Construction of the development will have temporary impact that could be mitigated to some extent.							

10. IMPACT ASSESSMENT FOR THE NO PROJECT ALTERNATIVE

This Chapter presents the findings of the environmental impact assessment for the no-project alternative.

From the impacts assessed in the previous sections, it is clear that habitat and flow rate alterations are the two main concerns. With reference to both the conditions will be permanently altered and impacts cannot be mitigated (habitat alteration through inundation) or only partially mitigated (maintaining base flows).

From a purely ecological perspective, the no project alternative will best ensure maintenance of ecological integrity within the system with the current rocky habitat in fast flowing clear water being maintained. In addition the PES of the system will most likely remain unchanged and the more sensitive aquatic taxa populations will most likely remain intact.

11. CONSULTATION PROCESS

11.1 CONSULATION PROCESS FOLLOWED

Engagement with Interested and Affected Parties (I&APs) forms an integral component of the EIA process. I&APs have an opportunity at various stages throughout the EIA process to gain more knowledge about the proposed project, to provide input into the process and to verify that their issues and concerns have been addressed.

The proposed project was announced in April 2014 to elicit comment from and register I&APs from as broad a spectrum of public as possible. The announcement was done by the following means:

- The distribution of Background Information Documents (BIDs) in English and IsiXhosa;
- Placement of site notices in the project area and Municipal offices (Tsolo and Qumbu);
- Placement of advertisements in one regional (The Herald) and two local (Daily Dispatch and the Mthatha Fever) newspapers; and
- Publication of all available information on the DWA web site (www.dwa.gov.za/mzimvubu).

The Draft Scoping Report (DSR) was made available for a 30 day public comment period in May 2014. All documents were uploaded to the web, notification letters were sent out, the summary of the DSR was translated into isiXhosa, distributed to all registered stakeholders and hardcopies of the full report and translated summary report were available at public places. Additionally, three public meetings were held in the affected areas, Siqhungqwini, Tsolo and Lalini respectively. An Authorities Forum Meeting with all relevant authorities was held in the Eastern Cape on the 28 May 2014. This was to assist the authorities with commenting on the relevant documentation.

Comments received from stakeholders were captured in the Issues and Response Report (IRR) which formed part of the Final Scoping Report (FSR). The FSR was made available to the public for a 21 day comment period on 13 June 2014 and was submitted to the Department of Environmental Affairs (DEA). Comments received during the Final Scoping public comment period were compiled and an updated IRR was submitted to DEA on 8 July 204 and uploaded to the website. The FSR was accepted by DEA with certain conditions on 15 July 2014. Following this, a newsletter was compiled and translated to isiXhosa, explaining everything that has happened to date as well as what is to come. Both the English and isiXhosa versions were electronically distributed to all registered stakeholders and hardcopies were distributed by the local facilitators in the affected areas.

The Draft Environmental Impact Assessment Report (DEIR), its summary (translated into isiXhosa), the various specialist studies, the Environmental Management Programmes (one for the construction and operation of the project, and one for the borrow areas and quarries) as well as the Water Use Licence Application will be made available for a period of thirty (30 days) for stakeholders to comment. Hardcopies will be made available at the same venues as the DSR and all documents will be uploaded to the website. The availability of these documents as well as the announcement of the upcoming public meetings in Siqhungqwini, Tsolo and Lalini will be advertised on the Eastern Cape SABC radio station, Umhlobo Wenene FM, which has a

listenership of over 4 million people. Another Authorities Forum Meeting is scheduled for October 2014.
Stakeholder comments will be taken into consideration with the preparation of the final documents. The availability of the final documents will be announced prior to submission to the decision-making authority. Once a decision has been made by the DEA, all stakeholders will again be notified.

The following issues were sourced from the Issue and Response Report (Final Version 1) as submitted to the Department of Environmental Affairs with the Final Scoping Report.

11.2 SUMMARY OF COMMENTS RECEIVED

Table 43: Issues related to the Reserve determination and aquatic ecology

Issue/Comment/Question	Date received	Origin	Response
Inappropriately dumped waste (such as cans and plastic bags) will also pollute the dam and could cause the water pipes to become blocked.	09.06.2014 via fax	Sivuyise Mange (Resident) Asanda Zihlwele (Resident) Zukisa Madasa (Resident)	The Environmental Management Programme applicable to the construction of the dam has waste management requirements that all Contractors must adhere to. These will be monitored for compliance.
Will the Reserve determination go all the way to the mouth of the river? The potential impacts on the estuary need to be considered and managed.	28.05.2014 AFM	John Geeringh (Eskom)	The Tsita River contributes a small percentage of the flow in the Mzimvubu River that reaches the estuary. The Ntabelanga/Lalini system will always be operated in a manner that fulfills the EWR downstream of the HEP outfall, both in terms of minimum and maximum flows. The project is also not expected to impact of the water quality. The Reserve determined for the estuary indicated that if a dam of 1.5MAR at Ntablalanga would support the estuarine EWR. The Ntabalanga dam will be a 1.2 MAR Dam while the Lallini dam is a 0.36 MAR Dam. These figures are in line with the Reserve determination of the estuary which will support the Best Attainable State for the estuary. The impact on the estuary is therefore predicted to be negligible and will most likely support the prescribed ecostatus for the estuary.
The Mzimvubu river is one of the main rivers flowing in the Eastern Cape Drakensberg and Pondoland Coast water source areas, these have <3% protection and are critical for water supply. This should be taken into account during the EIA.	23.06.2014 via email	Dean Muruven (World Wildlife Fund)	Part of the purpose of the project is to supply domestic water needs of communities in the project area. In addition, the Reserve determination undertaken in the feasibility study took into account basic human needs of communities living downstream of the two dam sites. The findings of the Reserve study will be revisited during the EIA to confirm the availability of water for human needs.
Stakeholder stated that soil	09.06.2014 via	Sivuyise Mange	Soil erosion is indeed a big issue in this

erosion may be a potential problem.	fax	(Resident)	catchment. The Department of Environmental Affairs has therefore initiated a Catchment Rehabilitation and Management Programme aimed at addressing this and related issues. This project includes the removal of alien invasive species, rehabilitation of eroded areas and other land management exercises. The project has already commenced. Should any activities of the Catchment Rehabilitation and Management Programme (e.g. the construction of soil erosion abatement structures) require environmental authorisation or a water use licence these are not included in the applications that we have submitted for the dams, and separate EIAs will have to be undertaken for them. There is close liaison between the catchment management and Mzimvubu Water Project teams to focus their initial activities on areas that will most benefit the dams.

12. IMPACT STATEMENT

Impact assessment summary: Impact assessment results are tabulated below.

Impact	Construction and first filling		Operational phase	
Mitigation status	Unmitigated	Mitigated	Unmitigated	Mitigated
Roads and Infrastructure	Very low	Very low	Very low	Very low
Electricity Generation and Distribution impact on habitat	Medium low	Low	Medium low	Very low
Electricity Generation and Distribution impact on flow dependant species	Medium low	Low	Medium low	Very low
Electricity Generation and Distribution impact on species diversity	Medium low	Low	Low	Medium low
Electricity Generation and Distribution impact on SCC	Low	Very low	Low	Very Low
Dam impact on habitat	High	High	High	Medium high
Dam impact on flow dependant species	High	High	High	Medium high
Dam impact on species diversity	High	High	Medium high	Medium high
Dam impact on SCC	High	Medium high	Medium high	Medium low

- **Dam construction and operation:** In terms of both dam construction and first filling phase, greatest impact pertains to habitat alteration/destruction as well as natural flow rate and the impact can be considered a high level impact. These impacts result in secondary impacts on flow sensitive species, species of conservation concern and aquatic biodiversity in general. The effects (inundation of habitat upstream of the dam walls and disruption of natural flow downstream) are considered high impact and permanent and hence also applicable to the operation phase. In terms of dam size alternatives, the impact on the aquatic system will be largely the same with only slight impact in terms of scale, moving more towards a local impact compared to a site impact. Very little mitigation is available to reduce the impacts of these proposed developments. In order to facilitate migration Eelways should be incorporated into the design of the dam.

In terms of flow rate, base flows need to be maintained during both the construction/initial filling and operation phases. Without periodic, seasonal floods with associated flushing of the river system, impacts such as silting/sedimentation and decrease in general water quality is a possibility. In addition periods of higher flow will be required to provide environmental ques to the aquatic ecology of the area. In order to facilitate abstraction of water from Ntabelanga Dam electricity would have to be generated at Lalini Dam. With peaking generation the system will be subject to daily unnatural variations in water level and flow rates, which will negatively affect flow sensitive species, and as a result decrease biodiversity which could have a significant impact on the aquatic ecology, especially if peaking takes place year round. With seasonal peak flow during winter only, such negative effects can be restricted to a single season.

Electricity generation and distribution: Construction of such infrastructure will be of low impact if mitigated. Mitigation includes minimising the spatial footprint of the development to the greatest degree possible, with special reference to avoiding erosion, silting and sedimentation within the aquatic system. During the operation phase discharge through the Lalini Dam tunnel into the river will also be applicable. The section of river below the dam wall up to the tunnel discharge point will be largely subjected to base flow as defined by the EWR except in times of heavy rainfall, which may impact on the most flow sensitive biota. This may result in silting, sedimentation, decrease in water quality and excessive vegetation growth. The shorter the length of this section between the dam wall and discharge point, the smaller the area of impact. The tunnel must also be constructed and positioned in such a manner as to preclude erosion effects at times of peak discharge. Peak electricity generation is not deemed appropriate to the system as it will significantly impact on the ecology of the system. Poorly managed Base energy generation would impact on the system. Well managed base generation based on available water and based on the simulation of natural stream discharge patterns, as defined by the EWR, is deemed the most appropriate regime for the project.

Road and pipeline infrastructure: Construction of such infrastructure will be of low impact if mitigated. Mitigation again includes minimising the spatial footprint of the development to the greatest degree possible, with special reference to avoiding erosion, silting and sedimentation within the aquatic system during both construction and operation. During the operation phase increased run-off from hard surfaces may also result in erosion and construction design must ensure that operational phase impacts are suitably managed.

13. CONCLUSION AND RECOMMENDATIONS

Construction of the dam will have a high impact in terms of habitat and natural flow rate alteration as well as impacts on the habitat upstream of the proposed dams. This may in turn have negative effects on flow sensitive species, species of conservation concern (particularly mayflies and also eels) and biodiversity in general. Impact will be high and permanent and dam size will have little effect (spatial scale only) on overall aquatic impact. The instream flow requirements of the systems are to be adhered to at all times. Peak electricity generation is not deemed appropriate to the system as it will significantly impact on the ecology of the system. Poorly managed base energy generation would impact on the system. Well managed base generation based on available water and based on the simulation of natural stream discharge patterns, as defined by the EWR, is deemed the most appropriate regime for the project.

Construction of electricity, road and pipeline infrastructure will be of low impact, if the spatial footprint of the development is minimised to the greatest degree possible, with special reference to avoiding erosion, silting and sedimentation within the aquatic system.

Throughout the life of the project ongoing aquatic biomonitoring must take place and if any trends are observed where impacts on the aquatic ecology is becoming unacceptable, measures to reduce the impacts must be immediately implemented. All aquatic biomonitoring should be undertaken by a suitably qualified and South African River Health Program (SA RHP) accredited assessor.

14. REFERENCES

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APPENDIX A: IHIA DATA
(JUNE 2014)

Instream Zone Habitat Integrity

	Weights	14	13	13	13	14	10	9	8	6		
Reach	**ASSESSMENT DATE**	**Water abstraction**	**Flow modification**	**Bed modification**	**Channel modification**	**Water quality**	**Inundation**	**Exotic macrophytes**	**Exotic fauna**	**Solid waste disposal**	**Total Score (%)**	**Classification**
TS1	**20 April 2014**	2	1	2	0	2	0	0	8	3	93.6	A (Unmodified)
TS4	**18 April 2014**	2	1	2	0	4	0	0	8	2	87.4	B (Largely natural)
TS7	**21 April 2014**	1	4	6	8	4	0	0	0	3	78.2	C (Moderately modified)
TS8	**17 April 2014**	2	1	2	0	2	0	0	8	3	75.4	C (Moderately modified)

None	*Small*	*Moderate*	*Large*	*Serious*	*Critical*

Riparian Zone Habitat Integrity

	Weights	13	12	14	12	13	11	12	13		
Reach	**ASSESSMENT DATE**	**Vegetation removal**	**Alien encroachment**	**Bank erosion**	**Water abstraction**	**Flow modification**	**Channel modification**	**Water quality**	**Inundation**	**Total Score (%)**	**Classification**
TS1	**20 April 2014**	11	7	2	0	0	0	0	0	85.5	B (Largely natural)
TS4	**18 April 2014**	13	11	1	0	0	0	0	0	72.4	C (Moderately modified)
TS7	**21 April 2014**	14	8	14	0	0	0	0	0	72.8	C (Moderately modified)
TS8	**17 April 2014**	11	7	2	0	0	0	0	0	76.9	C (Moderately modified)

None	*Small*	*Moderate*	*Large*	*Serious*	*Critical*

REACH	**ASSESSMENT DATE**	**INSTREAM HABITAT**	**RIPARIAN ZONE**	**IHI SCORE**	**CLASS**
TS1	**20 April 2014**	93.6	85.5	89.5	B (Largely natural)
TS4	**18 April 2014**	87.4	72.4	79.9	B (Largely natural)
TS7	**21 April 2014**	78.2	72.8	75.5	C (Moderately modified)
TS8	**17 April 2014**	75.4	76.9	76.2	C (Moderately modified)

Instream Zone Habitat Integrity

Weights		14	13	13	13	14	10	9	8	6		
Reach	**ASSESSMENT DATE**	**Water abstraction**	**Flow modification**	**Bed modification**	**Channel modification**	**Water quality**	**Inundation**	**Exotic macrophytes**	**Exotic fauna**	**Solid waste disposal**	**Total Score (%)**	**Classification**
TS2	**20 April 2014**	0	2	2	4	4	0	0	0	4	88	B (Largely natural)
TS3	**20 April 2014**	1	4	6	8	4	0	0	0	3	87.1	B (Largely natural)
TS5	**20 April 2014**	2	1	2	0	2	0	0	8	3	75.4	C (Moderately modified)
TS6	**19 April 2014**	2	2	12	13	2	0	0	2	2	71.6	C (Moderately modified)
TS9	**21 April 2014**	1	4	5	8	4	0	0	0	3	69.5	C (Moderately modified)

None *Small* *Moderate* *Large* *Serious* *Critical*

Riparian Zone Habitat Integrity

Weights		13	12	14	12	13	11	12	13		
Reach	**ASSESSMENT DATE**	**Vegetation removal**	**Alien encroachment**	**Bank erosion**	**Water abstraction**	**Flow modification**	**Channel modification**	**Water quality**	**Inundation**	**Total Score (%)**	**Classification**
TS2	**20 April 2014**	13	9	13	0	2	2	0	0	66.9	C (Moderately modified)
TS3	**20 April 2014**	14	8	14	0	0	0	0	0	76.6	C (Moderately modified)
TS5	**20 April 2014**	11	7	2	0	0	0	0	0	76.9	C (Moderately modified)
TS6	**19 April 2014**	13	11	12	0	0	9	0	0	65.1	C (Moderately modified)
TS9	**21 April 2014**	11	14	9	0	0	0	0	0	74.3	C (Moderately modified)

None *Small* *Moderate* *Large* *Serious* *Critical*

REACH	**ASSESSMENT DATE**	**INSTREAM HABITAT**	**RIPARIAN ZONE**	**IHI SCORE**	**CLASS**
TS2	**20 April 2014**	88.0	66.9	77.4	C (Moderately modified)
TS3	**20 April 2014**	87.1	76.6	81.9	B (Largely natural)
TS5	**20 April 2014**	75.4	76.9	76.2	C (Moderately modified)
TS6	**19 April 2014**	71.6	65.1	68.4	C (Moderately modified)
TS9	**21 April 2014**	69.5	74.3	71.9	C (Moderately modified)

APPENDIX B: IHAS SCORE SHEETS
(APRIL 2014 AND JUNE 2014)

TS 1 – APRIL 2014

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)

River Name: TSITSA
Site Name: TS1
Date: 20/04/2014

SAMPLING HABITAT	**0**	**1**	**2**	**3**	**4**	**5**
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
SIC Score (max 20):				**23**		

VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
Vegetation Score (max 15):					**6**	

OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m^2 = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m^2	rocks	1-2m^2	<1m^2	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
Other Habitat Score (max 20):					**12**	
HABITAT TOTAL (MAX 55):					**41**	

STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
STREAM CONDITIONS TOTAL (MAX 45)						**36**
TOTAL IHAS SCORE (%):					**77**	

TS 1 – APRIL 2014

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)

River Name: TSITSA
Site Name: TS1
Date: 02/06/2014

SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			23		
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				5	
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				16	
	HABITAT TOTAL (MAX 55):				44	
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX					27
	TOTAL IHAS SCORE (%):				71	

TS 2 – APRIL 2014

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)

River Name: UNNAMED TRIB
Site Name: TS2
Date: 20/04/2014

SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			20		
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				0	
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				12	
	HABITAT TOTAL (MAX 55):				32	

STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX 45)					35
	TOTAL IHAS SCORE (%):				67	

TS 2 – JUNE 2014

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name:						
Site Name: TS2	**Date**: 02/06/2014					
SAMPLING HABITAT	**0**	**1**	**2**	**3**	**4**	**5**
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			**20**		
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				**0**	
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'corr' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				**12**	
	HABITAT TOTAL (MAX 55):				**32**	
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX 4					**33**
	TOTAL IHAS SCORE (%):				**65**	

TS 3 – APRIL 2014

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)

River Name: UNNAMED TRIB
Site Name: TS3 | **Date**: 20/04/2014

SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			14		

VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				0	

OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				12	
	HABITAT TOTAL (MAX 55):				26	

STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX 45)					26
	TOTAL IHAS SCORE (%):				52	

TS 3 – JUNE 2014

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name:						
Site Name: TS3	**Date**: 02/06/2014					
SAMPLING HABITAT	**0**	**1**	**2**	**3**	**4**	**5**
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			14		
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				0	
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				12	
	HABITAT TOTAL (MAX 55):				26	
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX					26
	TOTAL IHAS SCORE (%):				52	

TS 4 – APRIL 2014

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)

River Name: TSITSA
Site Name: TS4
Date: 18/04/2014

SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						

SIC Score (max 20): 17

VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75

Vegetation Score (max 15): 7

OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m^2 = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m^2	rocks	1-2m^2	<1m^2	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						

Other Habitat Score (max 20): 12

HABITAT TOTAL (MAX 55): 36

STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						

STREAM CONDITIONS TOTAL (MAX 45) 30

TOTAL IHAS SCORE (%): 66

TS 4 – JUNE 2014

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name:						
Site Name: TS4	**Date**: 02/06/2014					
SAMPLING HABITAT	**0**	**1**	**2**	**3**	**4**	**5**
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			16		
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				7	
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				12	
	HABITAT TOTAL (MAX 55):				35	
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX 30					30
	TOTAL IHAS SCORE (%):				65	

TS 5 – APRIL 2014

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)

River Name: INTU
Site Name: TS5
Date: 20/04/2014

SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			11		
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				0	
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				12	
	HABITAT TOTAL (MAX 55):				23	
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX 45)					21
	TOTAL IHAS SCORE (%):				44	

TS 5 –JUNE 2014

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name:						
Site Name: TS5	**Date**: 02/06/2014					
SAMPLING HABITAT	**0**	**1**	**2**	**3**	**4**	**5**
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			12		
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				4	
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				12	
	HABITAT TOTAL (MAX 55):				28	
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX					23
	TOTAL IHAS SCORE (%):				51	

TS 6 –APRIL 2014

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)

River Name: UNNAMED TRIB
Site Name: TS6 | **Date**: 19/04/2014

SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
SIC Score (max 20):				18		
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
Vegetation Score (max 15):					11	
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
Other Habitat Score (max 20):					11	
HABITAT TOTAL (MAX 55):					40	

STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
STREAM CONDITIONS TOTAL (MAX 45)						30
TOTAL IHAS SCORE (%):					70	

TS 6 –JUNE 2014

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name:						
Site Name: TS6	**Date**: 02/06/2014					
SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):		18			
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				11	
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				11	
	HABITAT TOTAL (MAX 55):				40	
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX 45):				29	
	TOTAL IHAS SCORE (%):				69	

TS 7 –APRIL 2014

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)

River Name: TSITSA
Site Name: TS7
Date: 21/04/2014

SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			**22**		

VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				**7**	

OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				**11**	
	HABITAT TOTAL (MAX 55):				**40**	

STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX 45)					**31**
	TOTAL IHAS SCORE (%):				**71**	

TS 7 –JUNE 2014

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name:						
Site Name: TS7	**Date**: 03/06/2014					
SAMPLING HABITAT	**0**	**1**	**2**	**3**	**4**	**5**
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):		22			
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):			7		
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):			11		
	HABITAT TOTAL (MAX 55):			40		
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX 4				31	
	TOTAL IHAS SCORE (%):			71		

TS 8 – APRIL 2014

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)

River Name: TSITSA
Site Name: TS8
Date: 17/04/2014

SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			22		

VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				9	

OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				14	
	HABITAT TOTAL (MAX 55):				45	

STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX 45)					30
	TOTAL IHAS SCORE (%):				75	

TS 8 – JUNE 2014

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name:						
Site Name: TS8	**Date**: 03/06/2014					
SAMPLING HABITAT	**0**	**1**	**2**	**3**	**4**	**5**
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			**22**		
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				**10**	
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				**14**	
	HABITAT TOTAL (MAX 55):				**46**	
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX					**30**
	TOTAL IHAS SCORE (%):				**76**	

TS 9 – APRIL 2014

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name:						
Site Name: TS9	**Date**: 21/04/2014					
SAMPLING HABITAT	**0**	**1**	**2**	**3**	**4**	**5**
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			16		
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				0	
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				14	
	HABITAT TOTAL (MAX 55):				30	
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX 45)					36
	TOTAL IHAS SCORE (%):				66	

TS 9 – JUNE 2014

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)

River Name:
Site Name: TS9 | **Date**: 03/06/2014

SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			16		
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				3	
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				14	
	HABITAT TOTAL (MAX 55):				33	
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX 45):					35
	TOTAL IHAS SCORE (%):				68	

APPENDIX C: SASS5 SCORE SHEETS
(APRIL 2014 AND JUNE 2014)

TS1 – APRIL 2014

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 20/04/2014	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3					Athericidae	10				
E: °	**TURBELLARIA**	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: TS1	**ANNELIDA:**						Gerridae*	5		1		1	Ceratopogonidae	5				
RIVER: TSITSA	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2	A	A		A
SITE DESCRIPTION: UPSTREAM OF NTABA	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION: WARM / CLEAR	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10				
TEMP: 18.6 °C	Amphipoda	13					Notonectidae*	3		1		1	Empididae	6				
Ph: 8.78	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: mg/l	Atyidae	8					Veliidae/M. veliidae*	5					Muscidae	1				
Cond: 0.9 mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1				
BIOTOPES SAMPLED:	**HYDRACARINA**	8	1			1	Cordalidae	8					Simuliidae	5	A	A		A
SIC: 4 TIME: minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC: 2	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5				
BEDROCK:	Perlidae	12	A			A	Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
M VEG IC: 1 DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12	B			B	Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:YES	Heptageniidae	13		1		1	Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW: MEDIUM	Leptophlebiidae	9					**CASED CADDIS:**						Thiaridae*	3				
TURBIDITY: MEDIUM	Oligoneuridae	15	A			A	Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9	B			B	Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**		85	37	0	115
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					**NO OF TAXA:**		10	7	0	15
	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**		9	5.3	0	7.7
	Chlorolestidae	8					Pisuliidae	10					**IHAS**:	77%				
	Coenagrionidae	4		1		1	Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					**COMMENTS**:					
	Protoneuridae	8					Elmidae/Dryopidae*	8	A			A	* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5					SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4	A			A	Hydrophilidae*	5		1		1	VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10	A			A	1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

TS1 – JUNE 2014

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 02/06/2014	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3					Athericidae	10				
E: °	**TURBELLARIA**	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: TS1	**ANNELIDA:**						Gerridae*	5					Ceratopogonidae	5				
RIVER: TSITSA	Oligochaeta	1			A	A	Hydrometridae*	6					Chironomidae	2			A	A
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10				
TEMP: 14.4 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 7.1	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: mg/l	Atyidae	8					Veliidae/M..veliidae*	5					Muscidae	1				
Cond: 518 mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1				
BIOTOPES SAMPLED:	**HYDRACARINA**	8					Cordalidae	8					Simuliidae	5			A	A
SIC: TIME: minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5	A			A
AQUATIC VEG: DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12	A		A	B	Hydropsychidae >2 sp	12	A			A	Hydrobiidae*	3				
SAND:	Caenidae	6	1		1	A	Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9			1	1	**CASED CADDIS:**						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15	A		A	B	Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9	A		A	B	Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**		71	12	67	88
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					**NO OF TAXA:**		8	2	9	12
	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**		9	6.0	7	7.3
	Chlorolestidae	8					Pisuliidae	10					**IHAS**:	71%				
	Coenagrionidae	4					Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**						TADPOLES / FROGS					
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					**COMMENTS**:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5					SWC = South Western Cape					
	Aeshnidae	8	A	1	A	B	Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4	A	1		A	Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

TS2 – APRIL 2014

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 20/04/2014	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S:°	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E: °	TURBELLARIA	3					Corixidae*	3			A	A	Blepharoceridae	15				
SITE CODE: TS2	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5				
RIVER: UNNAMED TRIB. TSITSA	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2			A	A
SITE DESCRIPTION: REPRESENTATIVE	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION: WARM / CLEAR	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 17.2 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 8.75	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: mg/l	Atyidae	8					Veliidae/M..veliidae*	5					Muscidae	1				
Cond: 0.8 mS/m	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1	1			1
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5	A			A
SIC: 4 TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6	A		A	B	Bulininae*	3				
GRAVEL: 3	Baetidae >2 sp	12	B		B	B	Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND: 3	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS: YES	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW: LOW	Leptophlebiidae	9	A		A	A	CASED CADDIS:						Thiaridae*	3				
TURBIDITY: LOW	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9	B		A	B	Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		59	0	55	70
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		9	0	8	12
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		7	0.0	7	5.8
	Chlorolestidae	8					Pisuliidae	10					IHAS:		67%			
	Coenagrionidae	4					Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					COMMENTS:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5	1			1	SWC = South Western Cape					
	Aeshnidae	8	A		A	A	Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6			A	A	Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4	A			A	Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

TS2 – JUNE 2014

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 02/06/2014	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3					Athericidae	10				
E: °	**TURBELLARIA**	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: TS2	**ANNELIDA:**						Gerridae*	5					Ceratopogonidae	5				
RIVER: TSITSA	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2				
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10				
TEMP: 14.6 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 7.3	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: mg/l	Atyidae	8					Veliidae/M..veliidae*	5					Muscidae	1				
Cond: 18.1 mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1				
BIOTOPES SAMPLED:	**HYDRACARINA**	8					Cordalidae	8					Simuliidae	5			**A**	**A**
SIC: TIME: minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5			**1**	**1**
AQUATIC VEG: DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4			**A**	**A**	Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12	**A**		**A**	**B**	Hydropsychidae >2 sp	12	**A**			**A**	Hydrobiidae*	3				
SAND:	Caenidae	6	**A**		**A**	**B**	Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					**CASED CADDIS:**						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9	**A**			**A**	Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**		49	0	38	63
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					**NO OF TAXA:**		6	0	6	9
	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**		8	0.0	6	7.0
	Chlorolestidae	8					Pisuliidae	10					**IHAS**:	65%				
	Coenagrionidae	4					Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					**COMMENTS**:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5					SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6	**A**		**A**	**B**	Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4	**A**			**A**	Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

TS3 – APRIL 2014

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 20/04/2014	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3					Athericidae	10				
E: °	**TURBELLARIA**	3					Corixidae*	3	**A**		**A**	**A**	Blepharoceridae	15				
SITE CODE: NTABA TRIB 2 (TS3)	**ANNELIDA:**						Gerridae*	5					Ceratopogonidae	5				
RIVER: UNNAMED TRIB	Oligochaeta	1	**1**			**1**	Hydrometridae*	6					Chironomidae	2	**A**		**B**	**B**
SITE DESCRIPTION: REPRESENTATIVE	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION: WARM / CLEAR	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10				
TEMP: 24.2 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 9.08	Potamonautidae*	3	**1**			**1**	Pleidae*	4					Ephydridae	3				
DO: mg/l	Atyidae	8					Veliidae/M. veliidae*	5					Muscidae	1				
Cond: 13 mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1	**1**		**1**	**1**
BIOTOPES SAMPLED:	**HYDRACARINA**	8	**1**			**1**	Cordalidae	8					Simuliidae	5				
SIC: 2 TIME: minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4			**A**	**A**	Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6	**B**			**B**	Hydropsychidae 2 sp	6	**B**			**B**	Bulininae*	3				
GRAVEL: 3	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND: 2	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS: YES	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW: LOW	Leptophlebiidae	9	**A**			**A**	**CASED CADDIS:**						Thiaridae*	3				
TURBIDITY: LOW	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9	**A**		**A**	**A**	Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**		75	0	35	79
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					**NO OF TAXA:**		14	0	7	15
	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**		5	0.0	5	5.3
	Chlorolestidae	8					Pisuliidae	10					**IHAS**:		52%			
	Coenagrionidae	4					Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					**COMMENTS**:					
	Protoneuridae	8					Elmidae/Dryopidae*	8	**A**		**1**	**1**	* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5	**A**			**A**	SWC = South Western Cape					
	Aeshnidae	8	**A**		**A**	**A**	Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6	**A**			**A**	Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

TS3 – JUNE 2014

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 02/06/2014	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3					Athericidae	10				
E: °	**TURBELLARIA**	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: TS3	**ANNELIDA:**				1	1	Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2			A	A
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10				
TEMP: 18.2 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 7.2	Potamonautidae*	3			A	A	Pleidae*	4					Ephydridae	3				
DO: mg/l	Atyidae	8					Veliidae/M..veliidae*	5					Muscidae	1				
Cond: 22.3 mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1				
BIOTOPES SAMPLED:	**HYDRACARINA**	8					Cordalidae	8					Simuliidae	5	A		A	B
SIC: TIME: minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5			A	A
AQUATIC VEG: DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6	A		B	B	Hydropsychidae 2 sp	6	A			A	Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12			B	B	Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					**CASED CADDIS:**						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9	A			A	Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**		50	0	52	77
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					**NO OF TAXA:**		7	0	10	13
	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**		7	0.0	5	5.9
	Chlorolestidae	8					Pisuliidae	10					**IHAS**:	52%				
	Coenagrionidae	4					Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**						TADPOLES / FROGS					
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					**COMMENTS**:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5			A	A	SWC = South Western Cape					
	Aeshnidae	8	A		B	B	Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6	A		B	B	Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10	A			A	1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

TS4 – APRIL 2014

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 18/04/2014	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3					Athericidae	10				
E: °	**TURBELLARIA**	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: NTABA WALL (TS4)	**ANNELIDA:**						Gerridae*	5					Ceratopogonidae	5				
RIVER: TSITSA	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2	**1**		**1**	**A**
SITE DESCRIPTION: NTABALONGA WALL	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION: WARM / SUNNY	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10				
TEMP: 20.8 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 8.57	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: mg/l	Atyidae	8					Veliidae/M..veliidae*	5		**1**		**1**	Muscidae	1				
Cond: 14 mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1	**1**			**1**
BIOTOPES SAMPLED:	**HYDRACARINA**	8					Cordalidae	8					Simuliidae	5	**1**			**1**
SIC: 4 TIME: 2 minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5				
BEDROCK: 1	Perlidae	12	**A**			**A**	Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
M VEG IC: 1 DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4	**B**			**B**	Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12	**A**	**A**	**A**	**B**	Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND: 4	Caenidae	6	**A**		**A**	**B**	Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS: YES	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW: MEDIUM	Leptophlebiidae	9					**CASED CADDIS:**						Thiaridae*	3				
TURBIDITY: LOW	Oligoneuridae	15	**A**			**A**	Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
AGRICULTURAL	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**		85	22	36	85
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					**NO OF TAXA:**		12	3	5	13
NONE	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**		7	7.3	7	6.5
	Chlorolestidae	8					Pisuliidae	10					**IHAS**:	66%				
	Coenagrionidae	4					Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**						C. CAR					
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					**COMMENTS**:					
NONE	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5		**A**		**A**	SWC = South Western Cape					
	Aeshnidae	8	**A**			**A**	Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6	**1**		**1**	**A**	Hydraenidae*	8					S = Stone & rock					
LIMITED RECENT DISTURBANCES	Libellulidae	4	**A**			**A**	Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10	**1**		**1**		1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

TS4 – JUNE 2014

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 02/06/2014	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3					Athericidae	10				
E: °	**TURBELLARIA**	3					Corixidae*	3	**A**			**A**	Blepharoceridae	15				
SITE CODE: TS4	**ANNELIDA:**						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2				
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10				
TEMP: 17.3 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 8.1	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: mg/l	Atyidae	8					Veliidae/M..veliidae*	5					Muscidae	1				
Cond: 14.2 mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1				
BIOTOPES SAMPLED:	**HYDRACARINA**	8					Cordalidae	8					Simuliidae	5	**A**			**A**
SIC: TIME: minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5				
BEDROCK:	Perlidae	12	**A**			**A**	Dipseudopsidae	10					Tipulidae	5	**A**			**A**
AQUATIC VEG: DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
M VEG IC: DOM SP:	Baetidae 1sp	4			**A**	**A**	Hydropsychidae 1sp	4			**A**	**A**	Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6	**A**	**A**		**B**	Hydropsychidae 2 sp	6	**B**			**B**	Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6	**A**			**A**	Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13	**A**			**A**	Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					**CASED CADDIS:**						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**		76	11	19	89
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					**NO OF TAXA:**		11	2	4	14
	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**		7	5.5	5	6.4
	Chlorolestidae	8					Pisuliidae	10					**IHAS**:		65%			
	Coenagrionidae	4					Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					**COMMENTS**:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5		**A**	**A**	**B**	SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6	**A**		**B**	**B**	Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4	**A**			**A**	Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10	**A**			**A**	1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

TS5 – APRIL 2014

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 20/04/2014	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S:°	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E: °	TURBELLARIA	3					Corixidae*	3	A	A		B	Blepharoceridae	15				
SITE CODE: TS5	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5				
RIVER: INTU	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2	A		B	B
SITE DESCRIPTION: ABOVE CONFLUENCE	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION: WARM / CLEAR	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 23.3 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 8.68	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: mg/l	Atyidae	8					Veliidae/M. veliidae*	5		A		A	Muscidae	1				
Cond: 1 mS/m	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1	1			1
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5				
SIC: 2 TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC: 0	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK: 0	Perlidae	12	A			A	Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4			A		Hydropsychidae 1sp	4	A			A	Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6	B				Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL: 4	Baetidae >2 sp	12		B		B	Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND: 3	Caenidae	6	A			A	Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS: YES	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW: LOW	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY: LOW	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		42	20	6	53
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		8	3	2	9
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		5	6.7	3	5.9
	Chlorolestidae	8					Pisuliidae	10					IHAS:		44%			
	Coenagrionidae	4					Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					COMMENTS:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5					SWC = South Western Cape					
	Aeshnidae	8	A			A	Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

TS5 – JUNE 2014

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 02/06/2014	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3					Athericidae	10				
E: °	**TURBELLARIA**	3					Corixidae*	3		A		A	Blepharoceridae	15				
SITE CODE: TS5	**ANNELIDA:**						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2			A	A
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10				
TEMP: 20.6 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 7.7	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: mg/l	Atyidae	8					Veliidae/M..veliidae*	5					Muscidae	1				
Cond: 14.3 mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1				
BIOTOPES SAMPLED:	**HYDRACARINA**	8					Cordalidae	8					Simuliidae	5				
SIC: TIME: minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6		A	A	B	Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6	A		A	B	Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					**CASED CADDIS:**						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**		14	9	14	25
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					**NO OF TAXA:**		2	2	3	5
	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**		7	4.5	5	5.0
	Chlorolestidae	8					Pisuliidae	10					**IHAS**:	51%				
	Coenagrionidae	4					Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					**COMMENTS**:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5					SWC = South Western Cape					
	Aeshnidae	8	1			1	Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

TS6 – APRIL 2014

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET																		
DATE: 19/04/2014	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3					Athericidae	10				
E: °	**TURBELLARIA**	3					Corixidae*	3		**A**		**A**	Blepharoceridae	15				
SITE CODE: TS6	**ANNELIDA:**						Gerridae*	5					Ceratopogonidae	5				
RIVER: UNNAMED TRIB	Oligochaeta	1	**1**		**A**	**A**	Hydrometridae*	6					Chironomidae	2	**A**		**B**	**B**
SITE DESCRIPTION: REPRESENTATIVE	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10				
TEMP: 24.2 ° C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 8.49	Potamonautidae*	3	**A**		**A**	**A**	Pleidae*	4					Ephydridae	3				
DO: mg/l	Atyidae	8					Veliidae/M..veliidae*	5					Muscidae	1				
Cond: 0.8 mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1				
BIOTOPES SAMPLED:	**HYDRACARINA**	8					Cordalidae	8					Simuliidae	5				
SIC: 4 TIME: minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
M VEG IC: 2 DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: 3 DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6	**B**		**A**	**B**	Bulininae*	3				
GRAVEL: 4	Baetidae >2 sp	12	**B**	**B**		**B**	Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND: 3	Caenidae	6	**A**			**A**	Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS: YES	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW: LOW	Leptophlebiidae	9	**A**	**A**		**A**	**CASED CADDIS:**						Thiaridae*	3				
TURBIDITY: LOW	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9	**A**			**A**	Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**		71	49	26	86
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					**NO OF TAXA:**		12	7	6	15
	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**		6	7.0	4	5.7
	Chlorolestidae	8					Pisuliidae	10					**IHAS**:	70%				
	Coenagrionidae	4		**1**		**1**	Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					**COMMENTS**:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5	**A**	**B**		**A**	SWC = South Western Cape					
	Aeshnidae	8	**A**	**1**	**A**	**A**	Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6	**A**		**A**	**B**	Hydraenidae*	8		**A**		**A**	S = Stone & rock					
	Libellulidae	4	**B**			**B**	Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

TS6 – JUNE 2014

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 02/06/2014	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3					Athericidae	10				
E: °	**TURBELLARIA**	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: TS6	**ANNELIDA:**						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2	**A**			**A**
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10				
TEMP: 20.1 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 7.1	Potamonautidae*	3	**A**			**A**	Pleidae*	4					Ephydridae	3				
DO: mg/l	Atyidae	8					Veliidae/M..veliidae*	5					Muscidae	1				
Cond: 9.2 mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1				
BIOTOPES SAMPLED:	**HYDRACARINA**	8					Cordalidae	8					Simuliidae	5	**A**			**A**
SIC: TIME: minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5			**A**	**A**
AQUATIC VEG: DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6	**A**	**A**	**A**	**B**	Hydropsychidae 2 sp	6	**A**		**A**	**B**	Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6	**A**		**1**	**A**	Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					**CASED CADDIS:**						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9	**A**			**A**	Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**		66	11	42	71
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					**NO OF TAXA:**		11	2	7	12
	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**		6	5.5	6	5.9
	Chlorolestidae	8					Pisuliidae	10					**IHAS**:	69%				
	Coenagrionidae	4					Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**						TADPOLES					
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					**COMMENTS**:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5	**A**	**B**	**B**	**B**	SWC = South Western Cape					
	Aeshnidae	8	**B**		**A**	**B**	Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6	**A**		**A**	**B**	Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10	**A**			**A**	1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

TS7 – APRIL 2014

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 21/04/2014	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S:°	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E: °	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: LALENI U/S (TS7)	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5				
RIVER: TSITSA	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2	A		A	
SITE DESCRIPTION: UPPER LALENI DAM	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION: HOT / CLEAR	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 22.8 ° C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 8.81	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: mg/l	Atyidae	8					Veliidae/M. veliidae*	5		B		B	Muscidae	1				
Cond: 14 mS/m	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5	1			1
SIC: 5 TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12	A			A	Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: 1 DOM SP:	Baetidae 1sp	4			1		Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: 2 DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6	B			B	Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12	B	A		B	Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND: 3	Caenidae	6			1	1	Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS: YES	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW: LOW	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY: LOW	Oligoneuridae	15	B			B	Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15	1			1	Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		107	21	22	116
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		12	3	5	13
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		9	7.0	4	8.9
	Chlorolestidae	8					Pisuliidae	10					IHAS:		71%			
	Coenagrionidae	4					Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					COMMENTS:					
	Protoneuridae	8					Elmidae/Dryopidae*	8	1			1	* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5					SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6	A		A	A	Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4	B	1	A	B	Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12	1			1	Psephenidae	10	A			A	1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

TS7 – JUNE 2014

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET																		
DATE: 03/06/2014	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3		**A**	**A**	**B**	Athericidae	10				
E: °	**TURBELLARIA**	3					Corixidae*	3	**A**			**A**	Blepharoceridae	15				
SITE CODE: TS7	**ANNELIDA:**						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1			**A**	**A**	Hydrometridae*	6					Chironomidae	2	**A**		**A**	**B**
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10				
TEMP: 12.1 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 7.8	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: mg/l	Atyidae	8					Veliidae/M..veliidae*	5		**A**	**A**	**B**	Muscidae	1				
Cond: 12.6 mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1				
BIOTOPES SAMPLED:	**HYDRACARINA**	8					Cordalidae	8					Simuliidae	5				
SIC: TIME: minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4	**1**			**1**	Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6	**A**			**A**	Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12			**A**	**A**	Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6			**A**	**A**	Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					**CASED CADDIS:**						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
	Prosopistomatidae	15	**1**		**1**	**A**	Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**		36	12	54	67
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					**NO OF TAXA:**		6	3	9	12
	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**		6	4.0	6	5.6
	Chlorolestidae	8					Pisuliidae	10					**IHAS**:	71%				
	Coenagrionidae	4		**A**	**1**	**A**	Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**						TADPOLES					
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					**COMMENTS**:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5					SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6	**A**		**A**	**B**	Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

TS8 – APRIL 2014

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 17/04/2014	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3					Athericidae	10				
E: °	**TURBELLARIA**	3					Corixidae*	3	1		A	A	Blepharoceridae	15				
SITE CODE: TS8	**ANNELIDA:**						Gerridae*	5					Ceratopogonidae	5				
RIVER: TSITSA	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2				
SITE DESCRIPTION: NEAR LALENI WALL	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10				
TEMP: 22.8 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 8.79	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: mg/l	Atyidae	8					Veliidae/M..veliidae*	5					Muscidae	1				
Cond: 13 mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1				
BIOTOPES SAMPLED:	**HYDRACARINA**	8					Cordalidae	8					Simuliidae	5	B		A	B
SIC: 5 TIME: minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC: 3	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5				
BEDROCK:	Perlidae	12	B			B	Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
M VEG IC: 1 DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4					Ancylidae	6	1			1
M VEG OOC: 1 DOM SP:	Baetidae 2 sp	6		A	A		Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL: 3	Baetidae >2 sp	12	B			B	Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND: 2	Caenidae	6	A			A	Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS: YES	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW: MEDIUM	Leptophlebiidae	9					**CASED CADDIS:**						Thiaridae*	3				
TURBIDITY: LOW	Oligoneuridae	15	C			C	Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**		87	6	14	87
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					**NO OF TAXA:**		11	1	3	11
	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**		8	6.0	5	7.9
	Chlorolestidae	8					Pisuliidae	10					**IHAS**:		75%			
	Coenagrionidae	4					Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					**COMMENTS**:					
	Protoneuridae	8					Elmidae/Dryopidae*	8	A			A	* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5					SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6	A			A	Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4	B			B	Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10	A			A	1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

TS8 – JUNE 2014

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 03/06/2014	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S:°	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E: °	TURBELLARIA	3					Corixidae*	3		A	A	B	Blepharoceridae	15				
SITE CODE: TS8 (DS)	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1	A		A	B	Hydrometridae*	6					Chironomidae	2			A	A
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 20.1 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 7.6	Potamonautidae*	3					Pleidae*	4	A		A	B	Ephydridae	3				
DO: mg/l	Atyidae	8					Veliidae/M..veliidae*	5					Muscidae	1				
Cond: 12.3 mS/m	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5	A		A	B
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4	A			A	Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6			A	A	Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12	A		A	B	Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13	A	A	A	B	Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15	A		A	B	Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15	A		A	B	Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9			A	A	Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		79	21	99	114
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		10	3	13	16
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		8	7.0	8	7.1
	Chlorolestidae	8					Pisuliidae	10					IHAS:	76%				
	Coenagrionidae	4					Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					COMMENTS:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5		A		A	SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6	A			A	Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4	B		A	B	Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10			A	A	1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

TS9 – APRIL 2014

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 21/04/2014	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S:°	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E: °	TURBELLARIA	3					Corixidae*	3			A	A	Blepharoceridae	15				
SITE CODE: TS9	ANNELIDA:						Gerridae*	5	1			1	Ceratopogonidae	5				
RIVER:	Oligochaeta	1			1	1	Hydrometridae*	6					Chironomidae	2	B		B	B
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION: WARM / CLOUDY	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 19.4 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 8.78	Potamonautidae*	3	A			A	Pleidae*	4					Ephydridae	3				
DO: mg/l	Atyidae	8					Veliidae/M. veliidae*	5					Muscidae	1				
Cond: 10 mS/m	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1	1			1
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5	A			A
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1 sp	4	A			A	Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6	B			B	Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW: LOW	Leptophlebiidae	9	A			A	CASED CADDIS:						Thiaridae*	3				
TURBIDITY: LOW	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9	A			A	Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		61	0	6	65
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		12	0	3	14
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		5	0.0	2	4.6
	Chlorolestidae	8					Pisuliidae	10					IHAS:		66%			
	Coenagrionidae	4					Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					COMMENTS:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5	A			A	SWC = South Western Cape					
	Aeshnidae	8	1			1	Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4	1			1	Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

TS9 – JUNE 2014

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 03/06/2014	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3					Athericidae	10				
E: °	**TURBELLARIA**	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: TS9	**ANNELIDA:**						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1			1	1	Hydrometridae*	6					Chironomidae	2				
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10				
TEMP: 8.8 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 7.8	Potamonautidae*	3	A			A	Pleidae*	4					Ephydridae	3				
DO: mg/l	Atyidae	8					Veliidae/M..veliidae*	5		A	A	B	Muscidae	1				
Cond: 11.7 mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1				
BIOTOPES SAMPLED:	**HYDRACARINA**	8					Cordalidae	8					Simuliidae	5				
SIC: TIME: minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5	A		A	A
AQUATIC VEG: DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4	1			1	Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6	A	A	A	B	Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6	A		1	A	Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					**CASED CADDIS:**						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9	A			A	Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**		41	11	29	53
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					**NO OF TAXA:**		7	2	6	10
	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**		6	5.5	5	5.3
	Chlorolestidae	8					Pisuliidae	10					**IHAS**:	68%				
	Coenagrionidae	4					Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**						ALGAE ON ROCKS					
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					**COMMENTS**:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5					SWC = South Western Cape					
	Aeshnidae	8	1			1	Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6			A	A	Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					